NATIONAL

SMOKE ABATEMENT SOCIETY

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BRIGHTON CONFERENCE
1946

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Proceedings of the

THIRTEENTH ANNUAL CONFERENCE
of the
National Smoke Abatement Society

Held in Brighton

24th to 26th OCTOBER, 1946

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The opinion expressed in papers and discussions at Open Conferences of the Society are not necessarily the same as the Society's official views or policy.

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MESSAGE FROM THE LORD PRESIDENT OF THE COUNCIL

The Rt. Hon. Herbert Morrison, M.P. :—

I very much regret that press of Parliamentary duties has prevented my being present at the Conference of the National Smoke Abatement Society. The Society is carrying out work of the highest national importance. It is also work in which I am closely interested, as the Minister responsible for the Department of Scientific and Industrial Research, for the Department carries out research on atmospheric pollution.

It has been estimated that atmospheric pollution costs the nation about £50 millions a year. This is a conservative estimate, yet it is a grave figure and moreover it takes no account of the ill-health and dreariness caused by smoke. There are, however, two other aspects which make the solving of this problem imperative.

It has been estimated that the weight of smoke emitted in this country from burning coal is nearly three million tons a year. But that is not the whole of the waste, for smoke is always accompanied by unburnt gases ; and it has been shown by the Fuel Research Station of the Department of Scientific and Industrial Research that, with an industrial boiler chimney emitting black smoke, the loss may be as much as 10 per cent. of the heat of the coal. We cannot afford to waste our precious coal in this way, especially under present conditions. As you know, the success of the Ministry of Fuel and Power's campaign for industrial fuel economy in reducing the emission of sulphur dioxide and smoke by as much as ten per cent. in a single year shows what can be done if we are determined to conquer this menace.

Waste of coal is bad enough, but waste of manpower is even worse. It is waste of manpower in the pits to make such inefficient use of coal. Manpower is also required for cleaning up the mess caused by smoke, and this is no inconsiderable item. So the work of the Society is aimed at conserving our two most precious commodities—coal and manpower—as well as money.

We should have a national drive to make the public smoke-conscious. Smoke in large quantities from industrial chimneys already rouses some feeling of resentment. I want that feeling increased, and aimed not only at the factory chimney but at the ordinary smoking domestic chimney, until public opinion will insist that smoke is anti-social and not to be tolerated.

THE PRESIDENTIAL ADDRESS

by

SIR GEORGE ELLISTON, M.C., M.A., J.P., D.L.
(Chairman of the Public Health Committee, City of London)

It is eight years since the Society last met for a full-scale national conference and I think perhaps as we look ahead to our future activities it may be interesting and helpful to glance back over the road that we have travelled to our present position.

As most of you will know, the story of smoke abatement is at least three centuries old, but there is not time to dwell on the great work of the early pioneers like John Evelyn. I wish to recount more particularly what has taken place within the present century.

When it began, the Coal Smoke Abatement Society, which had been formed to raise a protest against the atmospheric pollution of London, was only one year old. Manchester, whose smoke problem was and is scarcely less acute than that of London, was, for once, a whole decade behind the Metropolis, for it was not until 1909 that the Smoke Abatement League of Great Britain was formed in that city.

In London, the pioneer and driving force was our late President, Dr. des Voeux. As Treasurer of such a crack-brained organization, as it was then deemed to be, he had a more than unenviable uphill task in collecting the necessary meagre funds for administration and propaganda. With a courage which those of us who knew him so often witnessed, he at once descended upon the Mayor of a London borough to expound his gospel, only to be informed that there were places maintained at public expense for people as crazy as he was.

I should like you now to recall the message from the Lord President of the Council that was read to you only a few moments ago, for I think the story I have just told you and that message illustrates perhaps more graphically than volumes of print could do, the distance that our movement has travelled and the change that has taken place in public opinion, due in no small degree to its efforts, for be it remembered that in this country legislation follows and never precedes public opinion.

Meanwhile, in Manchester, the sister body concentrated on the industrial northern counties and very soon joined up with the movement in Scotland. It had as its Secretary Mr. E. D. Simon, now Sir Ernest Simon. Through all those years his interest in the subject has, if anything, intensified and we were delighted when, with a greater wisdom than is sometimes displayed by the powers that be, Sir Ernest was appointed Chairman of the Government's Fuel and Power Advisory Council. I hope by now you are all familiar with the Report on the Domestic Fuel Policy which has come from Sir Ernest's Council and which endorses so much of the Society's own policy. In my opinion this Report is one of the most helpful departmental documents issued during recent years, for it provides an invaluable source of information for everyone concerned with fuel economy and the public health problems of smoke abatement.

The friendly relations which all along existed between the two smoke abatement bodies resulted quite naturally in a marrying of the joint interests in 1929. Obviously the great progress made both in London and Manchester would not have been possible through the individual efforts of the two pioneers I have mentioned, great as they were. The London Secretary was our present Treasurer, Sir Lawrence Chubb, and in Manchester there were men like Will Melland, two names which I feel among many other stalwarts call for special mention in any review of the past work of the Society.

The ten years between the merger and the outbreak of war was a period of intensive effort and of rich results, which are only now becoming fully apparent. The war years halted visible progress but gave us an opportunity for developing bold new policies, some of which have already been adopted by the Government and local government authorities and others which we believe should be adopted at an early date are to be discussed at this Conference.

A Constructive Policy.

I regard this Conference as particularly important in that it will give a new direction and orientation to the Society's activities. We start afresh with the tremendous advantage that some of those things for which we were still battling in 1939 are now established Government policy. The Government is firmly committed to a policy of cleaner air. It would seem therefore, that the main task of the Society is not to dwell as formerly upon the ravages of atmospheric pollution, now universally recognized as a national waste, but the more constructive work as to how this pollution can be diminished most effectively and in the shortest possible time. The Society's policy is no longer a counsel of perfection ; it has now become a matter of urgent necessity on the lowest economic grounds alone. There is little use the Ministry of Fuel and Power and other Ministries lamenting the shortage of coal for every purpose, industrial, domestic and export when we scatter no less than 2½ million tons of it unburnt into the air to cause damage to our buildings and possessions, which with other costs conservative authorities have estimated at two million pounds per week.

Jaded as our minds are these days with all kinds of astronomical statistics, a mere 2½ million tons of coal a year is perhaps not sensational. Nevertheless it represents four days output for every miner in this country, and would be enough to provide an extra four or five hundredweight of fuel to every family during the coming winter. If the heat we lose through smoke and other allied results of wasteful burning could be harnessed to industry, the fuel crisis would be over and Mr. Shinwell's anxieties would vanish for ever more.

The serious manpower shortage is one of the reasons for the coal shortage. Yet, fantastic as it may seem, we are in effect employing ten thousand miners to produce smoke, and a far greater number of other people in clearing up and making good all the damage it does.

Appeal to Local Authorities.

Obviously, then, the most pressing task before the Society is to ensure that this saving of coal and manpower shall be brought about as quickly as possible. Therefore, we are encouraged in that no less a person than the Lord President of the Council himself has indicated the most effective way in which this can be achieved. There are at present affiliated to the Society over two hundred local government authorities, including most of the largest, many of medium size, and some small, so that we have a complete and representative cross-section of municipal thought and opinion with us. But there are more than 1,500 local government authorities in this country and upon them mainly rests the responsibility of educating public opinion in their respective areas, and having educated public opinion, of implementing legislative authority by preventing the production of smoke in their own areas, or if they do not themselves produce it, to prevent its importation from their neighbours.

Smoke knows no boundaries, and few areas in Britain are entirely free from its direct effects, while a substantial part of the smoke bill is paid for by those who live in the cleanest parts as much as by the remainder. The cost of smoke to trade and industry, for instance, is paid for in the long run by the consumer, whether he lives in Sheffield or St. Ives.

So it is imperative that all local authorities should join in the fight against smoke. I would take this opportunity of welcoming to this conference the delegates of those local authorities which are not yet members of the Society, or which are being represented at one of our gatherings for the first time. We hope they will come in and help us. The Society is these days very largely a body composed of local authorities, and it is devoting much of its present limited resources to their service in one way or another. We are anxious to extend these services and to develop new ones, and for the Society to become, as it is in fact fast doing, the central bureau of information and assistance in all aspects of smoke prevention activity. At present, alas, more is demanded of us than we can possibly do, and the surest remedy is for us to have from a far greater number of local authorities the very modest measure of support we seek. I do hope that this appeal may go back to your respective Councils.

As Chairman of the City of London Health Committee, perhaps I may be allowed to mention two steps taken during the past year by the Corporation in the cause of Smoke Abatement. Encouraged by this Society they first considered the creation of smokeless zones within the city but they found the problem was complicated by the smoke output from the great railway stations and from steamships in the port. For the time being therefore they had to be content with securing in a Private Bill, now on the Statute Book, a clause requiring prior approval by the City Health Department of all new fuel-burning installations. That in itself was a considerable achievement, but the Corporation decided to go further and get expert advice on the possibilities of district heating for the extensive areas of the city devastated during the War. On the face of it, it seems an unique opportunity for the piping of heat and hot water to the acres of offices and warehouses which must be

rebuilt during the next few years. No previous scheme at home or abroad has dealt with a great commercial centre which has to be re-created *de novo* and where the advantages of district heating are more obvious. The Corporation are now awaiting a report from their expert adviser, and it is hoped that financial and other considerations will justify the adoption of a scheme which would automatically create smokeless zones in large areas of the city.

A Sub-committee of the Building Research Board have recently issued an Interim Memorandum on District Heating* which gives rather cautious encouragement to those local authorities who are considering the supply of heat and hot water to the central areas of large cities and to new housing estates, large and small. Judging by the views expressed at the recent Conference convened by the Ministry of Fuel it seems probable that the final report we now await from the Egerton Committee will approve the promotion by Local authorities of central heating schemes which give due consideration to the complex economic problems involved. Summing up the Fuel Conference discussion Mr. Donald Smith pointed out that all the experts who had contributed, irrespective of differences in systems advocated or examined, had agreed that district heating is practicable in Great Britain, that it should result in a great economy in fuel consumption, and that a higher standard of heating can be obtained with less fuel by means of district heating than by any of the traditional methods in use in Great Britain. No doubt members of this Society, and their guests, to-day well realize the urgency of bringing these facts to the early notice of the Committees who are planning their local housing schemes.

It is no exaggeration to say that the fight against the smoke evil, an evil from which we have suffered for so long, and which for generation after generation has wasted so much of the nation's health and wealth, is now entering its final and decisive stage. The full implementation of all that is contained in the Domestic Fuel Policy Report, the provision of new kinds of legislation and the early establishment of expanding smokeless zones—all these and other policies are practicable, and give well-defined objectives that, when they are won, will mean the virtual end of smoke. It is true that there may be some mopping-up operations, but they will be only of a minor or local character. We can look forward with confidence to great victories in the not-distant future, but, as we all know, it is the final effort that has to be the most intensive. I hope that in the years to come we shall be able to look back, as I have looked back for a moment this afternoon, and see that this conference in Brighton was in fact the beginning, and a worthy beginning, of that last offensive.

* Interim Memorandum on District Heating: Department of Scientific and Industrial Research. H.M.S.O., 3d. net.

FIRST SESSION

Friday Morning, 25th October, at 9.30.

SMOKE PREVENTION IN NEW HOUSES

Chairman : **The President, Sir George Elliston**

INTRODUCTION

The Society's views and policy for smoke prevention in new housing have been fully stated on previous occasions, and here they need only be summed up as a demand that all new houses, whether municipally or privately built, should be equipped to facilitate the fullest use of gas and electricity, that the possibilities of district heating should be carefully considered, and that the solid fuel appliances that are installed should be only of the improved types that are suitable for smokeless fuels, even if for the time being some bituminous coal has to be used in them. This policy is consistent with the recommendations of the *Housing Manual, 1944,* which have recently been strongly endorsed by the Fuel and Power Advisory Council in their report *Domestic Fuel Policy.*

It was agreed that it would be of considerable value to secure information on what is being done towards implementing these recommendations in the housing programme now starting, and to discuss the present position at this conference. To secure this information the co-operation was sought of those Regional Committees that have resumed activity, and for Scotland and the East Midlands the assistance of members of the Societey was invited. For areas not so covered the Society itself approached the local authorities. A Questionnaire was prepared, framed in a way that would simplify answering, and this has been used, with slight modifications in some cases, by each of the " Reporters " appointed to circularize the authorities and prepare a report on the replies received.

The questions asked were as follows :

Policy.

Q.1 Has the Authority considered the recommendations of the Housing Manual, 1944, and of the Fuel and Power Advisory Council in their recent report " Domestic Fuel Policy " ?

Q.2. What is being done to facilitate the use of gas and electricity on the lines recommended, by the provision of electric points and gas connections in all rooms where they are likely to be required ?

Q.3 What is being done, or attempted, in installing the new types of multi-fuel open fires, and openable stoves, etc. (i.e., those suitable for both smokeless fuel and bituminous coal) ? (N.B.—The fact is of course recognised that some of these appliances must for the present be smoke-producing because of the unavoidable use of raw coal. The immediate objective is to have the right appliances installed).

Q.4 What decisions have been made with regard to :

(a) Insulation of walls, roofs and hot water systems ?

(b) The provision of fuel stores to contain one to two tons of different solid fuels in separate compartments ?

Q.5 Has any consideration been given to :
(a) District heating or block heating for houses ?
(b) Block heating or central heating for flats ?

Progress.

Q.6 What actual progress is being made on the above lines ?

Q.7 What difficulties, criticisms, or prejuidices are being encountered ?

Q.8 What requires to be done to improve the present situation ?

Private Building.

Q.9 What is the attitude of, and what is being done by, private builders ?

Q.10 Have any steps been taken to induce them to follow the Housing Manual recommendations ?

Completed Installations.

Q.11 Any reports or opinions on improved heating installations already in use, including new types of openable stoves in prefabricated houses, which are in many cases burning coal and creating, because of the low chimney height, an objectionable smoke.

To avoid repetitions in the reports that follow the questions are referred to by their numbers.

It will be seen that in most cases a substantial proportion of the authorities approached responded to the request, and that the replies are therefore a reliable indication of the position as it exists generally at the moment, considered either nationally or regionally.

The Society is grateful to those who have prepared and issued the questionnaires, and analyzed the repiles in the form of the reports that follow.

It is appreciated that a consolidated summary of the reports, and a statement of the general conclusions to be drawn from them, would be of value. At the time of writing, however, all were not available, so that such a summary has had to be deferred until the final printing, when it may be possible also to incorporate observations made verbally during the conference discussion.

SCOTLAND

Copies of the questionnaire were sent to the larger local authorities and the following is a synopsis of their replies :—

Q.1 Although the authorities themselves may not all have considered the recommendations of the *Housing Manual* 1944 and of the Fuel and Power Advisory Council in their recent Report on Domestic Fuel Policy, these appear to have been kept in view by the officers responsible for the planning and erection of new houses.

Q.2 Electric or gas points are being provided in all rooms where they are likely to be required.

Q.3 Whilst a number of local authorities appear to desire to install the new types of fireplaces, these have so far only been installed in the Government temporary houses.

Q.4 (a) Regarding the insulation of walls, roofs and hot-water systems, the practice generally is to have cavity construction of main walls and, except in the case of concrete roofs, to cover roofs with boarding and felt before slating or tiling. Water supply pipes are wrapped.
(b) No separate compartments are provided for fuel storage. Accommodation for half-ton solid fuel is provided as recommended by the Scottish Housing Advisory Committee.

Q.5 (a) In a small number of instances, district heating has been under consideration, including a scheme for several hundred houses at Craigmillar, Edinburgh. A scheme for over 500 houses at the Priesthill Housing Scheme, Glasgow, has been approved by the City Council.
(b) In some instances also, block or central heating for flats has been considered, including a scheme in Glasgow for the provision of hostels for single women, and in multi-storey flats.

Q.6 It cannot be said that much actual progress is being made on the above lines. The traditional heating of buildings and domestic hot-water is still usual, but convection heating of cottages is being introduced. The newer knowledge, however, is receiving more attention and the results of experiments are awaited.

Q.7 The supply of modern appliances is still small and their cost is higher. More encouragement appears to be required by the Government Departments concerned to the local authorities to proceed with either district heating schemes or the installation of the new types of multi-fuel open fires and stoves.

Q.8 It is considered that the present situation can be met only by a more plentiful supply of better grade fuel and by a more adequate supply of fires and stoves suitable for smokeless fuel, as well as direct encouragement from the Government to local authorities. Another suggestion is that propaganda should be presented to the public in a popular or non-technical manner.

Q.10 There is very little private building, but with few exceptions traditional practice is being followed. The additional cost of appliances is stated to be the deciding factor.

Q.11. For the reasons stated, no steps have been taken to induce private builders to follow the *Housing Manual* recommendations.

Q.12 Although in most cases, the new types of openable stoves have not been sufficiently long in service to form an opinion, complaints have been received regarding the need for weekly cleaning of short chimney flues and the blackening of ceilings and surrounding walls. The type of cowl tends to direct smoke downwards. One reply states that the system of conducting warmed air from ducts behind fireplaces to bedrooms does not operate successfully and may be attributed to the position of inlet and outlet ventilation. Another reply advocates cheaper consumption cost of electricity to encourage its use.

Allan W. Ritchie,
President, Scottish Division.

NORTHUMBERLAND AND DURHAM

The Northumberland Durham Advisory Regional Smoke Abatement Committee has not met for several years and there is no Secretary, so I haxe taken on the duties of preparing a report on the heating installation in new houses for this Region.

The following authorities were circularised with a questionnaire drawn up on the lines suggested by Mr. Marsh, of the National Smoke Abatement Society :

County Borough Councils—
Newcastle-upon-Tyne, South Shields, and Sunderland.

Urban District Councils—
Ashington, Bedlingtonshire, Billingham, Blaydon, Chester-le-Street, Felling, Hebburn, Houghton-le-Spring, Longbenton, Newburn, Seaham Harbour, Seghill, Stanley and Washington.

Rural District Councils—
Chester-le-Street, Houghton-le-Spring, and Sunderland.

Northumberland and Durham County Councils were also circularized for information. The circulars were addressed to Medical Officers of Health, although it was realised that as the questionnaire dealt with matters relating to new house construction, the matter was really one for engineers and architects and I have to acknowledge with thanks the information provided by these officers.

Ten Councils replied to the questionnaire as follows :

Q.1 Every Council has replied that the Housing Manual of 1944 has been considered.

Q.2 As to the use of gas and electricity, three Councils have provided electricity only, three have given a choice of gas or electricity and four have provided both gas and electricity.

Q.3 Five Authorities are providing the new multi-fuel open fires of the convector type. Three Councils replied that the scheme was impracticable, as tenants, being miners, received free coal sometimes of a very poor quality. The remaining two Councils replied that one solid fuel burning fire is being placed in each house.

Q.4 (a) As regards insulation of walls, nine Authorities are making provision for insulation of walls, roofs and hot water system and one Authority is making no such provision.
(b) As regards the provision of separate fuel stores, no Authority reports that separate provisions for each type of solid fuel has been provided.

Q.5 (a) As regards district heating all Councils replied that consideration has been given to the question of district heating but no Authority has, as yet, installed it, although one area is introducing block heating into business premises, with flats above, together with the provision of a communal laundry.
(b) As regards block heating or central heating for flats, no Authority has, as yet, introduced this.

Q.6 All Authorities report that progress is bein made on the lines as mentioned above, the difficulty being that until better quality bituminous coal and smokeless fuel is available, little, if any progress will actually be made. One area states that as they are eight hundred feet above sea level, atmospheric pollution is practically nil.

Q.7 Criticism : Throughout the area there is still the conviction that the average person prefers to retain the open coal fire.

Q.8 As to what can be done to improve the present situation, the replies vary between bringing the cost of gas and electricity down and more supplies of the better types of fuel recommended by the Fuel and Power Advisory Council. One Authority goes so far as to state that the main offenders are the collieries.

Q.9 As regards the attitude of the private builders, in areas where there are private builders still carrying on, they seem to follow entirely the practice taken by the local authorities.

Q.10 As regards steps being taken for private builders to follow the Housing Manual, builders generally follow such recommendations, and the conditions under the Housing Manual have, in many cases, been pointed out to the private builders.

Q.11 A two years' experience by one Council with the "Ideal" Neo-fire has proved satisfactory and has influenced the decision to proceed with this type of installation in all new houses. In other areas, the schemes are not yet sufficiently developed for any opinion to be reported. In many areas, the objection which was raised at the last meeting of the Smoke Abatement Society, in connection with smoke pollution due to the low chimneys of prefabricated houses, seems to be substantiated in most areas in the North and the requirements are emphasised that solid smokeless fuels should be used in all prefabricated houses.

From all these replies, it would appear that in the North of England the average person is still sticking to the open coal fire and it is only by intensive propaganda, including practical demonstrations of the new

convector type of heating stove, that the average person will realise there are other and even more comfortable methods of heating a house than the open coal fire. Coke does not seem to have been mentioned in any of these replies, although it is a solid smokeless fuel and it can be burnt satisfactorily in an open grate if mixed with coal, or even by itself when first ignited by coal or gas. The time is too short in the post war period of new housing construction to come to any conclusion as to the benefits which may have been obtained from any new heating installations being installed ; the matter should be re-opened after a period of years.

Dr. A. S. Hebblethwaite,

Medical Officer of Health for Sunderland.

NORTH-WEST

In accordance with the request of the National Smoke Abatement Society, enquiries have been instituted from local authorities in the Society's North West Divisional Area, as regards policy and progress with fuel burning installations in new houses.

172 local authorities were approached and definite information was obtained from 16 county boroughs, 28 municipal boroughs, 32 urban districts and 9 rural districts, a total of 85.

The views expressed in each case were those of the officials, not necessarily those of the Council.

Whilst replies were not received from the whole of the local authorities approached, it is considered that the information obtained is representative of the whole position generally in the region, which includes North Wales, Cheshire, Lancashire, Westmoreland and Cumberland.

The basis of the enquiries and a summary showing the information obtained from each local authority is indicated in the appendix to this report.

The general situation indicated by the enquiries is as follows :—

Q.1 With few exceptions the whole of the local authorities have considered the recommendations of the *Housing Manual* and the report entitled " Domestic Fuel Policy."

Q.2 Similarly practically all the authorities are facilitating the use of gas and electricity by the provision of gas connections and electric points in all rooms where they are likely to be required for cookers, washboilers, fires, gas pokers and power.

Q.3 A large number of local authorities have decided to install these appliances in new houses, but over 50% have either arrived at no decision yet or have taken no action.

In one instance it is suggested that some of these appliances have not yet passed the experimental stage and in other cases, cost has been the decisive factor in not installing the appliances.

Q.4 (a) Only about a quarter of the local authorities report that special attention is being given to insulation of roofs

principally, by the use of felt.

Many authorities are specifying cavity walls, which in some cases are to be sealed, but in the main there is no special attempt at insulation.

As regards hot water systems in 14 instances the local authorities have decided on wrapping or lagging of pipes, and in 11 other cases it is reported that the system will be sited centrally in the house or short runs of pipe installed.

(b) Whilst some local authorities have decided to build fuel stores with separate compartments to hold different solid fuels, twice as many authorities are providing orthodox single fuel stores.

Q.5 62 local authorities have either not considered this form of heating or have not arrived at a decision.

18 have given the matter consideration, but are not taking any further action.

In only 3 instances are schemes proposed.

Central or block heating of flats is intended in 5 instances only.

Q.6 In over half of the cases there is no real progress to report, pre-war methods being still in use or no decisions having been arrived at as regards modern fuel burning installations.

Modern appliances are being installed in houses in course of erection or to be erected by 39 local authorities.

Q.7 Amongst the difficulties encountered by local authorities, high costs of installations and unsatisfactory supplies take the major place.

In many instances there is either a preference for open fires of the old type or a prejudice against the new types, sometimes on the grounds of appearance.

A number of local authorities report that no decision is yet possible because the houses are not completed and occupied.

Q.8 As might be expected the chief suggestion is improvement in the supply position and reduction in costs.

Other suggestions are for more publicity as regards the appliances concerned, extension of electricity supplies, the use of district heating and the discontinuance of manufacture of old type grates.

Q.9 Whilst many authorities state that no private building is in progress in their districts, a large number say that private builders are still following pre-war methods.

In 3 instances they are following the local authority's methods and in 11 cases they are willing to adopt modern appliances and systems in their building.

Q.10 It is the practice of the majority of local authorities not to draw the attention of private builders specially to the recommendations of the *Housing Manual*.

In one case it is stated that the builders' clients should

be educated in this respect because the builder often erects houses according to instructions.

Q.11 Mainly because the local authorities' housing schemes are not sufficiently advanced in many instances no observations are available.

In a few instances the tenants are reported to be satisfied with the appliances installed by the council, whilst in other cases it is stated that there has been insufficient experience on which to base an opinion.

Several local authorities report that low chimneys to openable stoves in prefabricated houses are a disadvantage and are likely to cause objectionable smoke, but actual complaints of smoke are recorded in only 3 instances.

Dr. C. Metcalfe Brown, M.D., D.P.H.,
Barrister - at - Law, Medical Officer of Health, Manchester, and Honorary Secretary, Manchester and District Regional Smoke Abatement Committee.

WEST RIDING OF YORKSHIRE

Copies of the Questionnaire were sent to 47 Constituent Authorities and 25 replies were received. The 25 Authoritites comprised 6 County Boroughs, 3 Municipal Boroughs, 15 Urban District Councils and one Rural District Council.

The following is an analysis of the replies.

Q.1 was answered in the affirmative by all.

Similarly with **Q.2** except where qualified by the remark (in two cases) " reduced in accordance with the requirements of the Ministry of Health " from which it would appear that to reduce cost the Ministry had advised a curtailment of the number of gas or electric points.

As regards **Q.3** one authority had a stock of old pre-war ranges which it desired to exhaust before purchasing new ones ; 19 had either installed multi-fuel ranges mostly of the back-to-back type or ranges capable of burning coke or coal or a mixture of both, while one authority preferred the old type of range because being a mining area the people insisted on burning raw coal. In the remaining 4 cases the matter was still under consideration.

The replies to **Q.4 (a)** respecting the insulation of roofs, walls and hot water systems showed a good deal of variation. In 14 the traditional methods were adhered to, in 10 nothing is being done, while one had not decided what to do.

Q.4 (b). Eight authorities proposed to provide double fuel stores, 16 single fuel stores and one authority failed to answer the question.

Q.5 (a). This was answered in the negative by all except two authorities where it was stated that the matter was still under consideration. The reason adduced by one authority for rejecting district heating was on the ground of expense.

Q.5 (b). This question was answered in the negative by all the

authorities except two which said the matter was under consideration. The majority of authorities did not possess flats and had no intention of building flats.

Q.6. Thirteen authorities had a varying number of houses in course of construction in which though not specifically stated one must assume the progress was satisfactory, in three progress was slow owing to the difficulty in obtaining appliances. In two building had not yet commenced and four ignored the question.

Q.7. Where this question was answered, the difficulty most emphasised was shortage or slow delivery of appliances.

Q.8. All authorities agree that what is most desirable is the speeding up of the delivery of appliances. Two authorities point out the need for better supplies of smokeless fuel at cheaper rates whilst two suggest that steps should be taken to educate the public in the use of smokeless fuel.

Q.9 and Q.10. These questions were answered by very few authorities, most of them saying that little or no private building is going on and such as is, is being undertaken on very much the same lines as before the war. One or two point out that the private builder is having to face the same difficulty with regard to appliances as the public authorities and frequently in the absence of modern appliances is compelled to fit old-fashioned types of grates.

Q.11. Of the 9 authorities who answered this question 6 had no complaints, one complained that the fire bars burnt out too quickly owing to the use of the wrong type of fuel, another that the amount of smoke emitted was excessive due to the burning of raw coal. One authority explained that it had experimented with a coke-burning Lefray fire adapted to a back-to-back range and fitted with hopper feed. The results had been satisfactory and this type was being installed in 300 houses. All answers related to prefabricated houses.

Comments.

The general impression gathered from the answers is that most of the Local Authorities are interested in the prevention of smoke and the installation of smokeless heating appliances. The difficulty they are up against and of which they complain is the lack of these appliances, slowness of delivery and restriction of choice. Many are being forced to install old-fashioned grates because of this lack. It is imperative, therefore, that something should be done to speed up the manufacture and rate of delivery of solid fuel burning grates designed to burn coke or other types of smokeless fuel. The supply position also requires some attention. at the moment supplies are extremely limited and the fuel is very expensive, indeed, in some cases more expensive than the best household coal. Until the price of coke can be reduced it is useless to try to pursuade householders to abandon coal.

The need for two fuel stores is questioned on ground of expense and one wonders whether two stores are actually necessary. A divided fuel store of adequate size would certainly go a long way to meet the difficulty but the best and most satisfactory way would undoubtedly be the use of one kind of fuel. If, as one authority states, it is possible to

fix a hopper feed using coke to a back-to-back range, that would be of undoubted value to the housewife who would thereby be relieved of the constant stoking which is necessary with a coke fire if it is to be kept alive and bright.

The suggestion that an education campaign to popularize the use of smokeless fuel should be undertaken is good and should receive serious consideration.

J. Johnstone Jervis,
Honorary Secretary.
Regional Smoke Abatement Committee.
West Riding of Yorkshire

SHEFFIELD, ROTHERHAM AND DISTRICT

The Questionnaire was submitted to the constituent authorities of the Sheffield, Rotherham and District Smoke Abatement, from the replies of whom the following report is compiled :

Q.1 The answer in each case is " Yes."

Q.2 In Sheffield provision is being made for gas cookers, either incorporated in the back-to-back stoves or as a separate unit. Electric points are being provided in living rooms and in all bedrooms for radiators. In Rotherham gas connections and electric points are provided in all houses now being erected by the Council. In private buildings increased gas connections are now being fixed. Rotherham R.D.C. reports electric points and gas connections in all rooms where they are likely to be needed ; in Rawmarsh U.D.C. houses at present being built have gas fires on both floors as well as coal fires ; and in Stocksbridge U.D.C. a fixed gas fire is provided in the living room and gas cooker in the working kitchen, with 15 amp. plugs in 4 rooms.

Q.3 Sheffield reports : Some of the new types of houses could have openable stoves but no particulars have yet been received from any manufacturers of a stove of this type at a price to compare with the open fire and back-boiler. Rotherham states that multi-fuel open fires and openable stoves are in very short supply. In Rotherham R.D. some of the new types of multi-fuel open fires will be provided when production is increased, but there is little hope of installing them in houses at present on hand. In Rawmarsh U.D.C. no multi-fuel open fires are being installed in houses now being erected, but Hattersley's independent boilers heat the domestic water circulation, cooking being done by gas. Stocksbridge state that the new types of fire were not available when the specification was being prepared.

Q.4 Sheffield : (a) Walls are of the 11in. cavity type and hollow blocks are used for partitions. Roofs are insulated by roofing felts; hot water pipes and cylinders insulated where necessary; (b) Coal places are provided of the size recommended in the

Rotherham : No decisions have yet been made with regard to the insulation of walls, roofs and hot water systems and the provision of fuel stores for different kinds of solid fuels.

Rotherham R.D. : (a) The usual provisions are being made for insulation ; (b) A 4ft. 6in. square fuel store to take the standard fuel box with two compartments in being provided in all future plans.

Rawmarsh U.D. : (a) Walls, nil ; roofs lined with roofing felt ; hot water system not insulated ; (b) Fuel stores to hold more than 1 ton, but not in different compartments.

Stocksbridge U.D. : (a) Cavity walls are unventilated—ground floors are solid. Will provide slag or glass wool to ceilings as soon as price permits ; (b) No—but outside " stove " can be used.

Q.5 Sheffield has considered a scheme for District Heating for the Parson Cross extension, but owing to the contours of the ground it would be too expensive and the Heating Engineers could not recommend it. In the other authorities District and Block heating systems are considered not to be applicable, and flats are not being erected.

Q.6 and Q.7 Little information is given under these questions, other than that indicated in the answers to previous questions.

Q.8 The reply from Sheffield states that while the new recommendations are no doubt an improvement, their present high cost is preventing their being more extensively used. Rotherham R.D. anticipates improvements in the delivery of material, and the following comment is made by Rawmarsh U.D. :

> No houses are yet occupied. The district contains three collieries, and it is therefore likely that many of our new houses will be occupied by mineworkers receiving " home coals." It remains to be heard what their reaction will be on occupying a house where all cooking is done by gas and there is but one coal-burning fireplace.

Q.10 and Q.11. Sheffield cannot say what is being done by private builders, and the reply from Rotherham R.D. is similar. In Stocksbridge private building is on pre-war lines, and in Rawmarsh only two pairs of houses are being built by private enterprise.

Q.12 The only comments on the question are from Sheffield, where it is stated that it is too early to give a definite opinion on the stoves in the temporary houses, but it is understood that the Ministry of Works have had to make quite a number of replacements of firebars. This may be due to the tenants not using the stoves properly. The reply from Stocksbridge

states that as far as can be checked, the cost of installing central heating with the addition of cooking and topping-up heat is about £29 per house more than pre-war normal fittings.

James Law,
Chief Smoke Inspector.

WEST MIDLANDS

Acting upon the instruction of the Executive Committee of the Midlands Joint Advisory Council for the Abatement of Smoke and Atmospheric Pollution, I sent out that Committee's modification of the National Society's Questionnaire to the Clerks of 114 Local Authorities. Sixty-four replies were received, coming from three County Councils, 9 County Boroughs, 20 Municipal Boroughs, 17 Urban Districts, 14 Rural Districts, with 1 unstated.

The modifications to the suggested questionnaire were as follows :

(1) Question 2. Add—"and what means of permanent ventilation, i.e., chimney or grating, is available where electric power points or gas connections are provided."

(2) Question 4(b). Amend to read—"the provision of fuel stores to contain different solid fuels in separate compartments."

(3) Question 8. Add—"bearing in mind Ministry of Health Supplement to Circular 76/46."

(4) Questions 9 and 10. Combined as Question 9.

In correlating the replies received from Local Authorities I find that :

Q.1 88% have considered the Housing Manual, 12% have not. No reply has been received in respect of the "Domestic Fuel Policy" report of the Fuel and Power Advisory Council.

Q.2 66% are providing both gas and electricity supplies and 27% electricity without gas. Gas is being supplied for cooking and The use of gas pokers, while electricity is being introduced mainly for heating, power and light. Permanent ventilation is provided by air bricks, louvred ventilators, etc., where chimneys are not provided.

Q.3 56% are installing the new type of grate, while 41% are fitting the old and 3% are all electric. The new grates include Siesta, Fulham, Eagle and Esse.

Q.4 (a) 57% cavity walls.

36% felted roofs, 33% normal pre-war construction. One Local Authority is employing breeze slabs under slates or tiles for insulation.

55% lagging hot water system. Two Local Authorities report that their hot water systems are so designed as to prevent heat loss by siting in the centre of houses.

(b) 23%—two compartments for fuel.

77%—one compartment only, of which one fifth are large enough to allow of partitioning.

Q.5 (a) 81% have not considered District heating. Of the remaining 19% who have, only two Local Authorities have decided to proceed with schemes, while one Local Authority plans to do so at a later date. The remainder are still undecided or have decided against this method on the grounds that it is unsuitable by reason of—

(i) the type of Local Authority concerned ;
(ii) difficulties over metering charges ; or
(iii) general cost of such an installation.

(b) Only six Local Authorities have considered block or central heating for flats.

Q.6 63% of Local Authorities have started building on the above lines.

Q.7 (i) Shortage of supply grates, smokeless fuels, materials and labour.
(ii) Prejudice in favour of open fire.
(iii) Free coal issues in the mining areas.
(iv) Cost of more modern grates and smokeless fuels.
(v) Cost of electricity or gas as compared with coal in rural areas.

Q.8 70% express no opinion. Of those who comment, some stress the need for more and cheaper smokeless fuel, with greater ease of delivery to the consumer. Others plead undue delay in supply in the more modern type of grate, pointing out that the grate which is available quickly—usually the old one—will inevitably go in. One Authority notes the faulty handling of new types of grate and the use of fuels for which they were not designed, and considers that there is real need for education of the individual householder as to the advantages of modern grates burning smokeless fuels. Another asks that the provision of electricity be generally extended to all rural districts.

Q.9/10 25-30% of private builders are co-operating to some extent, but in a number of the remainder, licence to build is meantime suspended or no building is in hand. The controlled cost of private building effectively cuts out all extras, thus the cheaper, i.e., old fashioned, type of grate goes in.

The Local Authorities go the length of suggesting that the private builder is not interested unless he happens to be under the control of and building on behalf of a Local Authority.

One Local Authority thinks that builders have a genuine grievance over the cost of the electric wiring required in the provision of all the electric power points demanded.

Q.11 70% expressed no opinion, but where replies were given these included one or more of the following comments :

(i) There has only been one summer since prefabricated houses with modern appliances came into use, thus it

is too early as yet to assess what improvement has resulted.

(ii) The chimney of prefabricated houses is too low, and the cowl fitted is unsuitable ; the chimney should be raised to prevent smoke hanging about.

(iii) The wrong fuel—i.e., bituminous coal—is in general use and heating by ducts in prefabricated houses is considered to be non-existent.

(iv) Where coke offered to the householder, it frequently has to be collected by the householder himself.

(v) Dampers intended to keep fire going overnight are seldom used, with no saving in labour or cost to the housewife, or lessening of smoke production.

(vi) Miners get an allowance of coal and will not burn anything else.

(vii) Through the combined effects of the density of prefabricated houses per acre, the low chimney and the use of wrong fuel, atmospheric pollution is undoubtedly being increased.

W. R. Martine, O.B.E., M.D., D.P.H.

(*Hon. Secretary, Midlands Joint Advisory Council*).

EAST MIDLANDS

The questionnaire was sent out to twenty-seven Local Authorities in the East Midlands Area during the month of July and I regret to say that only twelve replies had been received at the time of preparation of this report in September Three " Local Authority Members " of the Society failed to reply to the questionnaire.

A summary of the replies is given below :

Q.1 All twelve local authorities have considered the recommendations of the *Housing Manual, 1944,* but in one instance the authority has not considered the Fuel and Power Advisory Council's report *Domestic Fuel Policy*.

Q.2 All the replies indicate that provision is being made for electric points or gas connections in all rooms where they are likely to be required. Facilities for cooking and the space heating of bedrooms will be by gas or electricity. In one case immersion heater points are being provided to the hot water supply and in another electric **fires** are being fixed in bedrooms. One authority refers to the saving which results from the provision of electric fires and the consequent omission of flues to carry off fumes.

Q.3 Most authorities desire to fix the new types of multi-fuel open fires and openable stoves, etc., but some appear unable to do so because they are not readily obtainable. In only one case does it appear that no special equipment is being provided. One local authority refers to the fact that such stoves and

fireplaces are not popular in a colliery district. The supply position appears to be the dominant factor in many cases.

Q.4 Cavity walls are being provided externally by nine local authorities and roof felting is being fixed under the tiles by six authorities. In three instances the maximum allowable prices for new houses do not permit such requirements being incorporated. In only two cases are hot water cylinders being "lagged" and two-compartment fuel stores provided.

Q.5 Generally, district heating or block heating for houses has not been adopted but several authorities are watching developments in this connection. One authority is, however, considering a scheme of block heating in connection with a proposed group of old people's dwellings. In no case is it thought likely that blocks of flats will be erected and, therefore, the question of block heating or central heating has not arisen.

Q.6 Nine local authorities have incorporated the recommendations as to heating arrangements in schemes now in hand but only so far as the supply position allows. Several authorities also refer to the impossibility of complying in full with the recommendations because of the limitation in the cost of houses laid down by the Government.

Q.7 Difficulties, criticisms or prejudices are :

(a) Openable stoves, etc., are not popular with the general public and councillors in two areas.
(b) The cost has prevented three authorities from installing suitable appliances.
(c) In mining areas where many citizens receive an allowance of soft coal, there is a prejudice against openable stoves, etc.
(d) The main difficulty appears to be the supply position.

Q.8 Steps to improve the present position appear to be :

(a) Improvement in supplies of suitable appliances.
(b) Improvement in supplies of smokeless fuel.
(c) The provision of appliances at a reasonable cost.
(d) The education of the public in the advantages of smokeless air and in the use of modern appliances.

Q.9 The attitude of private builders appears to vary considerably. In many areas, little is being done in installing modern appliances in houses erected privately, the reasons given being high costs and the popularity of the open coal fire. There is, however, according to the replies received, a tendency for private builders to favour the proposals as to modern firegrates and stoves and in one case it is pointed out that less solid fuel heaters are now being installed than formerly.

Q.10. Under the small builders' scheme for the erection of houses for local authorities, private builders become acquainted with the recommendations but there appears to be no general

movement to induce private builders to follow the recommendations.

Q.11 It appears too early to make any full report on completed installations, but from the replies received, it appears that the openable stoves in prefabricated houses are proving satisfactory where they are used properly and where smokeless fuel is burnt. Many replies, however, state that supplies of suitable fuel are not available and that the tenants in many cases prefer an open fire so that the doors of the stoves are often kept in the open position with the consequent loss of efficiency.

A. Wade,
Chief Sanitary Inspector, Nottingham.

BRISTOL AND DISTRICT

In accordance with the request made by the Executive Committee of the Bristol and District Regional Smoke Abatement Committee, I have circularised all Local Authorities on the lines suggested by the National Smoke Abatement Society in their letter of June last to Mr. F. J. Redstone (Hon. Secretary). Nineteen questionnaires were sent out, fifteen were returned. (2 from County Boroughs, 7 from Urban Districts, 6 from Rural Districts).

The following summarizes the answers given to the questions put.

Q.1 Generally the answer is "Yes."

Q.2 In the newly erected houses in the Boroughs and Urban areas both gas and electricity installations are general, and where such services are available, in Rural Areas also.

Q.3 The installation of opening stove fires capable of burning anthracite fuel is a stock feature in construction of temporary houses. Little progress appears to have been made in the provision of new-type grates because they are not in adequate supply at the moment, but a number of Authorities have apparently considered the matter. An interesting point is raised by a coal producing area which states that there is little prospect of alteration to smokeless fuel unless it is produced locally!

Q.5 The City of Bristol Housing Committee has called for a Specialist's report but no decision has been reached. (This is the only Authority where the question has been answered).

Q.7 Generally the answer is "No." One Authority complains of inability to sweep flues (of openable fires) if bituminous coal is burned. (Reporter's note—Have they considered possibilities of sweeping the flue from top to bottom, i.e., at chimney level, in bungalow-type erections. This is practicable from the writer's own experience).

Q.9 Most Authorities have little or no private building at the present time. Others report no information. It can be taken

that where private building has been allowed, grates of traditional design have been installed.

Q.11 Application of this question is not general. Bristol has received a few complaints of domestic smoke arising from temporary houses. In Kingswood the Fuel Overseer made arrangements for supply of "Phurnod" anthracite fuel for all temporary houses (50). Other areas report no complaint or insufficient data upon which to give an answer. These apply mainly to industrial areas, but also include part of Rural Areas contiguous thereto. Grit nuisance arises in one area from use of pulverised fuel at an Electricity Generating Station, and in others from Gas Works. The low grade fuel supplied for industrial use is criticised. Oil fuel plant has given rise to complaints in one area, which also has a special problem arising from burning leather. Bristol, with its large industrial development, obviously has problems which are inapplicable to other constituent Authorities, but the Inspectorial Staff are dealing with any nuisance as and when it arises.

Geo. E. Curtis, F.S.I.A.,
Senior Health Inspector (Kingswood Urban).

GREATER LONDON

The Executive Committee of the Greater London Advisory Council for Smoke Abatement decided to co-operate with the National Smoke Abatement Society in obtaining information regarding the fuel-burning apparatus being installed in new houses. 96 local authorities were accordingly invited to provide answers to a questionnaire dealing with this matter. 48 authorities completed the questionnaire and the replies may be summarized as follows :

Q.1 46 local authorities said that both of the documents had been considered ; one authority still has them under consideration, and one did not give a direct answer, though it would appear from its other answers that the documents have been favourably considered.

Q.2 43 local authorities are providing for both gas and electricity ; 4 for electricity only ; and one is providing central heating using oil-fuelled boilers with automatic control.

Q.3 13 local authorities are providing multi-fuel open fires ; 6 are providing fires for coke burning only ; 4 are providing grates for smokeless fuel only ; and 2 are considering the question of multi-fuel open fires. 3 authorities are not installing multi-fuel open fires because they are unobtainable but will do so when they can get them ; 2 authorities merely say that multi-fuel fires are unobtainable ; 8 are providing multi-fuel and ordinary open fires ; 1 is providing central heating only ; 6 are providing ordinary open fires (in one case because they cannot obtain multi-fuel fires). One local

authority is trying to introduce openable stoves, another is doing nothing about it, and a third is using any type of stove available.

Q.4 (a) 29 local authorities are arranging to insulate walls, roofs, and hot water systems ; 3 walls and roofs ; 4 walls only ; 1 floors, roofs and hot water systems ; 1 walls and hot water systems ; 1 roofs only ; 2 hot water systems only. One is doing as much as possible, consistent with capital cost ; 1 is arranging to insulate as is "traditional" ; 1 has the matter under consideration ; 1 is doing nothing about it ; and 3 did not answer the question.

(b) 12 local authorities are providing separate fuel stores (one ton each) ; 9 providing one fuel store ; 12 a "reasonably adequate" fuel store ; 5 are providing 2 separate fuel stores of one-half ton each ; 1 is providing a small fuel store but is also setting up a bulk fuel store to serve the estate. 2 do not require to provide a fuel store (central heating) ; 1 has the matter under consideration ; 2 are not providing fuel stores ; 3 answered the question in an uncertain manner, and one did not answer it at all.

Q.5 (a) 30 authorities have not considered district heating ; one said it was impracticable, and another that it had been considered but not proceeded with because the Ministry of Health thought it would cause unjustifiable delay. 5 authorities said the matter had been considered ; 2 had considered it but not approved ; and 3 had considered it but found that the housing scheme was too small for it to run economically. 2 authorities will consider it in future schemes ; 1 authority is not erecting houses ; another considered it but could not obtain sufficient data to warrant its introduction ; one that the capital cost was too expensive, and one did not give a clear answer.

(b) 19 authorities had not given consideration to this matter ; 13 had given it consideration ; 4 had considered it but found their housing scheme too small. 1 authority had considered it but rejected it on the advice of the Ministry of Health ; 1 thought it was not applicable to their housing scheme ; 1 considered it but found it to be undesirable for the type of flats now contemplated ; 3 were considering it but were still undecided ; 1 had not yet dealt with its Flats scheme ; 1 thought the capital cost too expensive ; 2 did not propose to erect flats, and 2 did not answer.

Q.6 It is difficult to summarize the various answers to this question—the answer to questions 1 to 5 inclusive above, will enable one to form some idea of the progress made. In some cases the actual schemes embodying the proposals are in course of construction ; some are awaiting approval of tenders ; whilst others said that progress was slow, owing to delay in delivery of stoves. One authority is working on its pre-war arrangements to avoid delay, though some of

the modern ideas will be incorporated in its real post-war construction plan.

Q.7 14 authorities have met no difficulties, criticisms, or prejudices; 8 require more time before these can be assessed; 8 find the supply of materials the chief difficulty; 2 said that tenants require a coal fire in the living room and will not consider any other form of heating for this room. Two authorities said that the houses have not yet been occupied; and one said that the supply situation, together with the cost, often causes the scheme to be reduced, leaving only essentials to be included. One refers to the difficulty met by tenants in lighting smokeless solid fuels and also the high cost of electric heating. One said that it lacks detailed information regarding District Heating, particularly as to its cost. 11 authorities did not answer the question.

Q.8 13 local authorities consider that the supplies of appliances should be very much increased; 5 think it is too early to pass comment; 3 are of the opinion that the general public should be educated to smokeless fuel ideas by exhibitions and demonstrations. One authority considers that the price of electricity should be reduced; 1 would like to be assured that the supply of smokeless fuel will be maintained; 1 favours the control of licenses to manufacturers of obsolete appliances; 1 said that the cost generally should be reduced; 1 thought there should be recognition of the extra cost; 1 said, as regards District Heating, that the views of the Minister of Health should be obtained—it also thought that this subject was receiving the consideration of the Department of Scientific and Industrial Research and that the report of that body was not yet available. One authority regards the present action for the elimination of domestic smoke as satisfactory; 18 authorities did not answer the question, and two consider that no action is necessary.

Q.9 In 12 areas the "traditional" methods are being employed, and in one they are being employed because of the lack of experience as to how the general public will react to other types. In 11 areas there is no private building. One local authority said it could not interfere with what private builders do about it; in 2 areas the builders are not informed and therefore do nothing; in 2 private builders are adopting the recommendations; in one they are indifferent. In six areas private builders co-operate within limits of costs. 10 authorities did not answer and one is not concerned with the activities of private builders.

Q.10 8 authorities have taken such steps; 19 have taken no steps in this matter; 1 said it had no power to do so; 1 has no private builders; 1 said it was not concerned with private builders. 18 local authorities did not answer.

Q.11 23 local authorities have not evidence that this occurs ; 3 say that it does occur ; 5 have no prefabricated houses occupied yet ; and 17 did not answer.

Clifford Ratcliff,

Hon. Secretary,

Greater London Advisory Council for Smoke Abatement.

OTHER AREAS

(Compiled by the Society)

After requesting the Regional Smoke Abatement Committees and two of the Society's Divisions to send out the Housing questionnaire to the local authorities in their areas, it was seen that a number of districts were not covered, particularly in the south-east, south-west, and to a smaller extent in parts of the east and north-east. Accordingly 200 questionnaires were sent to the more important authorities in these areas by the Society itself, and the following report is based on the 80 replies received.

Q.1 All but two of the authorities state that the *Housing Manual* and *Domestic Fuel Policy* report recommendations have been considered.

Q.2 5 out of every 7 authorities appear to be making adequate provision for the use of gas and electricity, largely providing for a choice. One mentions the convection heating of bedrooms by electricity, 4 the provision of electric immersion heaters, 6 of points for gas pokers. Several refer to limitations due to cost controls, and two state that because of this they had had to reduce the provisions that had been planned. One authority admirably itemizes its plans as follows :

Gas and Electric points in kitchen.
Gas ignited coke grate witth back boiler in dining room.
Gas ignited coke grate without boiler in living room.
Electric points in dining and living rooms.
Convection heat and electric points in bedrooms.
Electric immersion heater in cylinder.

Q.3 From the smoke prevention point of view this is the key question. Nearly one-half of the replies are either vague or more definitely not satisfactory, but over one-half—46 out of 80—appear to be taking some action on the right lines, although in some cases the reference may be to equipment for temporary houses only. 15 specifically state that domestic boilers will be installed. 9 complain of the difficulties of supply, and 5 only cite cost as a deterrent.

Q.4 Roof insulation be felting appears to be common practice in the new houses, but there is little reference to wall insulation, except insofar as it is provided by cavity construction. One-third of the replies show that insulation is not being con-

sidered, in some cases because of cost. About one-half are jacketing hot water cylinders, and a smaller number are lagging hot-water pipes. A few are placing the hot water cylinder in a close-fitting insulated cupboard.

As regards fuel storage the answers are rather vague and not very satisfactory. About one-third are providing storage for two fuels, and a similar number refer to reasonable accommodation that will in some cases allow for division into two compartments.

Q.5 About one-quarter of the local authorities replying appear to have given some consideration to district heating. In some cases the matter has not yet been decided, in others it has been turned down for various reasons, including : first cost, smallness of housing estates, delay that would be met in completing schemes, lack of authoritative Government lead, and danger of subsidence in a hilly mining district.

About one-half are building flats, and of these a dozen are considering, or have decided upon, the incorporation of some form of central heating, or central hot-water supply.

Q.6 Little concrete information can be gleaned from this question. Progress is said to vary between "very satisfactory" and "good" to "slow" and "very little." Many of the answers refer only to the number of houses now under construction.

Q.7 This question has proved to be ambiguous. In some cases the answers have referred to the difficulties of the local authority ; in others to criticisms by users. Of the difficulties in installation, 11 authorities mention supply, and 13 cost. One-half enter the word "none" as the overall answer, but this is assumed to refer particularly to criticisms by users. Three cases are reported of openable stoves being criticized on account of high fuel consumption. This can have been caused only by lack of understanding of the means for control. Conservatism and some public favour for traditional methods are mentioned in two cases ; that tenants are not familiar with smokeless fuel in one ; lack of smokeless fuel in another, and in another the "improbability of the availability of smokeless fuel in sufficient quantities to allow the installation of appropriate appliances." Lack of cost data on district heating is mentioned in one case, and another cites a general tendency to favour gas and electricity for space heating and cooking.

Q.8 The replies include 26 references to the need for improving the supply of improved appliances ; 9 to price reduction ; 6 to improvement in fuel supply ; 4 to cheaper fuel ; 5 to the need for better publicity on the use and advantages of the new appliances in order to overcome initial prejudices, etc. 5 replies urge less regard for first cost, or an increase in the maximum cost per house permitted. 2 replies desire a Government lead on district heating.

Q.9 On what private builders are doing most replies give no concrete evidence, either owing to lack of information or to

the fact that there is little or no private building in progress. Of the replies that do give an indication of the attitude of private builders, 27 show little or no change from pre-war practice, with such references as "conservatism," "insistence on open fires burning bituminous coal," etc. Only 6 replies suggest a favourable, or co-operative attitude in respect of the new methods.

Q.10 Almost half the replies show that steps have been taken to induce private builders to follow the recommendations of the *Housing Manual*. A rather smaller number have not yet done so. One reply states : "No need for inducements. When modern appliances become available they will be used by private builders in preference to the old." One authority states that no licences will be issued unless private builders follow the *Housing Manual* ; but in another case it is said that "the Council have no control over private specifications."

Q.11 54 replies have nothing to report on opinions of appliances already in use. The remainder refer mainly, if not entirely, to installations in temporary houses. Of these 11 indicate satisfaction with the new appliances, and 3 say there are no complaints. A few complaints of high fuel consumption have already been mentioned, and in another case the verdict of tenants is said to be "not too favourable."

Smoke emission nuisances from temporary bungalows are referred to in 4 cases, and "no complaints" on this score are mentioned in 6 cases.

DISCUSSION

Arnold Marsh (National Smoke Abatement Society) opened the discussion by giving a general review of the reports submitted. In general the replies showed a fairly satisfactory awareness of the new standards of domestic heating installations and of the recommendations of the Housing Manual and the Domestic Fuel Policy report, even though the details revealed many difficulties and doubts, and some failures that might in part be attributed to the temporary problems of supply and concern about costs. Provision for the use of gas and electricity appeared usually to be adequate. The installation of the new multi-fuel fires and stoves, or the intention to install them when they are more readily available, was perhaps more general than might have been expected, although the proportion of authorities indifferent to this primary requisite for future smokelessness indicated that further efforts must be made to ensure the universal adoption of the appliances. The position with respect to the important fuel-saving factor of insulation was disappointing, although in many cases failure to employ effective constructional measures was no doubt due, unfortunately, to the need to restrict building costs. Similarly, much more could have been hoped for in the provision of two-compartment fuel stores. Provision for two fuels would be particularly useful during the transitional coal to smokeless fuel period, even in houses with only one fuel-burning appliance. District heating was being considered fairly widely, but so far few decisions to proceed with schemes were reported. There appeared to be a substantial demand for information about details and costs and for a lead from the Government. The attitude of private builders towards the new methods appeared to be very variable. On the one hand some interest was reported, but on the other there was a decided impression of "traditional" methods

being used. It appeared that many local authorities were either unable or unwilling to interfere with private practice. It was clear that the position would require close consideration by the Government departments responsible for the implementation of the Simon Report. The existence of objectionable smoke emission from the low-level chimneys of temporary houses was confirmed from a number of quarters. This was due to the use of bituminous coal in openable stoves where smokeless fuels should always be used. The trouble was no doubt due in part to difficulties in obtaining smokeless fuel, and there should be a special effort to secure it for the temporary houses. Education in the best use of the new appliances was probably a further factor of importance. As several reports mentioned, the difficulty was particularly serious in areas where temporary houses were occupied by miners, who received a relatively generous quantity of coal as a wage in kind. Here, of course, smokeless fuel was not wanted. This raised the general problem of the miner's home coal, which would require much careful—and understanding—thought. In conclusion, the reports were of considerable interest, both for the information they gave and that they did not give, and in the trends, rather than the achievements, they revealed. They reflected the difficulties of the present transitional stage, and it was probable that another questionnaire in a year or so, perhaps modified and improved, would show more clearly the actual progress that was being made towards applying the new standards of domestic heating and smoke prevention. Mr. Marsh continued by giving a brief report of important statements made at the recent "Fuel and the Future" conference of the Ministry of Fuel and Power. Sir Guy Nott-Bower, Joint Deputy Secretary of the Ministry had stated that the Ministries of Health, Fuel and Power and Works had accepted the Simon Report. An Interdepartmental Committee on Domestic Heating, with Sir Guy as Chairman, had been set up, representing the above Ministries and the Ministry of Supply. This had been divided into sub-committees. The two principal difficulties, Sir Guy had said, were the shortage of coal and the shortage of appliances for the immediate programme. A preliminary list of approved appliances had been prepared and the Ministry of Supply had placed "blanket" orders. A speed-up to reduce the shortage of foundry workers was being made. The replacement of appliances in existing houses would be considered. With regard to fuel, Sir Guy had said that the supply of smokeless fuel would be in the forefront of the programme of the National Coal Board. The South Wales coalfield was that in greatest need of reorganization, and an increasing supply of smokeless fuel from that area was to be expected. Sir Guy urged local authorities not to hesitate to put in new appliances. They were of the non-selective type, in which it was possible to burn bituminous coal as well as smokeless fuel. Alderman Charles Key, M.P., Parliamentary Secretary to the Ministry of Health had said that the Ministry would do all in their power to urge local authorities to install such improved appliances as had been fully tested and approved by the Government. They would only recommend appliances they were satisfied local authorities could afford. "Let me make it quite clear," Alderman Key had continued, "that much as we are concerned to keep housing costs down, we would not dream of cutting out an approved appliance from a local authority's plans merely on account of additional cost."

D. Cleave Cross (Institution of Gas Engineers) said that arising from a study of the regional reports based on replies to questionnaires submitted to Local Authorities, he wished to focus the attention of delegates upon four points :

(1) There appeared to be either a serious lack of appreciation or complete apathy of a large number of local authorities of the urgent national need for the prevention of the serious nuisance and ill effects of smoke. It could not be denied that it would be far more profitable for the country in every way, if the Ministry of Health were to plan to spend money more liberally in providing for clearer atmosphere and less smoke in the manner stated below, rather than have to spend the millions of pounds per annum as contemplated in their health service scheme for the curing or alleviation of pain and disease brought about by the existing unhealthy atmosphere of our towns and cities, and lack of sun due to smoke.

(a) Specifying that only approved smokeless burning appliances should be installed in domestic houses, and only smokeless fuel used.

(b) That all bedrooms should be provided with a chimney for adequate ventilation and removal of products of combustion from any form of smokeless burning fuel used for heating.

(c) Adequte insulation of roofs, walls and floors of buildings to conserve heat, and save waste of fuel.

(2) The second point upon which the attention of delegates was drawn arose from the pressing need for the utmost economy in the use of solid fuel. It was essential that only the correct grade and size of solid smokeless fuel which would burn with the greatest efficiency and least amount of waste, should be used in a domestic appliance. It was an accepted fact that the size fuel required to give the most efficient results in an open fire, was unsuitable for a small closed domestic boiler and vice versa. If the wrong fuel was used, then there was a loss of efficiency and waste. Therefore, it was essential to provide the householder with at least two compartments for the storage of fuel.

(3) It was suggested that the use of unsuitable and the wrong grade of coke in a domestic appliance was probably the chief cause of complaints sometimes made by delegates at conferences against the satisfactory performance of smokeless fuels. It was desirable to educate and encourage the householder to use the correct grade and size of fuel, then smokeless fuels would become more popular and it would lead to less smoke polluting the atmosphere.

(4) The last point raised was the short-sighted policy of local authorities in fitting up houses "all-electric" with no other form of energy for heating or cooking. The daily newspapers were continually warning the public that the electric grid system was overloaded, and it was periodically necessary to cut off supplies. Then why fit houses with only this one overloaded source of fuel? It was suggested that all houses should be provided with at least two different forms of fuel, such as electricity and gas and better still, the addition of a smokeless solid fuel appliance, so that the householder was not solely dependent upon one fuel, but had an alternative source of energy, should one of the above fail.

W. Beaumont (Coventry) said that the replanning and reconstruction of the bombed towns and cities, together with the enormous programme of housing with which the country was now faced, presented the greatest opportunity of our time for introducing into new houses smokeless grates and fuels, thereby greatly reducing atmospheric pollution from this source. With respect to Coventry, the city he represented, the housing problem had reached very serious dimensions. The waiting list for houses amounted to 15,000 and the city stood in need of 24,000 dwellings. The situation was being met by the Housing Committee with great energy and determination in spite of labour difficulties. Since the end of the war Coventry had built more houses in proportion to size than any other authority save one and had rehoused over 2,200 families. The actual number of houses of all classes completed up to date was 2,483. This number included 1,000 prefabricated bungalows erected or in course of erection on five housing estates. The bungalows were of the following types: Arkon, 491; U.S.A., 307; Phoenix, 50; Aluminium, 152. All these four types were provided with "Siesta" or similar types of openable grates, together with a gas or electric cooker. The occupiers were very impressed with the efficiency of this type of grate, both from the point of view of space heating and water heating. Although these openable stoves were intended only for the use of coke, it was the experience of the occupiers that a quantity of small coal was necessary to start a fire, with the result that in the early morning smoke was emitted in fairly large quantities, causing more or less a pall of smoke at a low level, about twelve or fourteen feet from the ground, which hung about around the dwellings unless there was a sufficient air movement to disperse it. A considerable percentage of this smoke could be prevented by the use of a gas poker for kindling the fire. With the low chimneys and low pitched roofs of the bungalows there was a great tendency on a calm day for smoke to hang about; very little dispersal takes place. In his opinion an effective remedy for preventing this smoke emission was by educating the householders in the

proper control of the stoves, e.g., attention to the damper, regular cleansing and removal of ashes from the ash pan and avoidance of using the stove as an incinerator for domestic refuse. Coventry Corporation had several schemes of district heating for the central reconstruction area of the city under consideration. No positive proposals had yet been decided upon, but it was felt that a scheme would be practicable in the central area, where the complete redevelopment would facilitate its provision.

Councillor A. Sweeney (Stocksbridge) said that a previous speaker had spoken of the lack of co-operation on the part of the Ministry of Health Regional Departments with the Local Authorities regarding the housing position. Regarding district heating for new estates, this had been given much consideration but was finally turned down because the geographical aspect did not lend itself to that form of heating. However, they did decide on central heating but the tenders received were approximately £110 per house above the Ministry's recommendation and of course they were not accepted. They cut out everything possible, except the central heating and although the figures were still higher than the Ministry's, they sent them in again. Again they were returned as not satisfactory. However, they were determined to keep their houses as they had submitted them the second time and decided to send a deputation to Leeds with the story that the only thing left to cut was the central heating; and as the price they had presented was within striking distance so to speak of their recommendations then they were prepared to ask the Ministry of Fuel and Power to intervene on their behalf, from an economical point of view. Whether it was the veiled threat of contacting another Ministry or the persuasive methods of the deputation he could not say, but this he could say, the deputation came back with permission to build, and their programme at that moment was well under way.

G. Gould Marsland (Cheltenham) stated that this was the first Conference of the Society he had attended and being greatly interested in the turn the discussion had taken was tempted to report what his Council had done with a view to reducing smoke nuisance. As the Officer responsible for housing development he had made certain recommendations in the pre-war period. These had resulted in an offer being made by the Gas Company, and subsequently accepted, to lay on a gas supply and provide points for cooker, domestic water heater and two bedroom fires all for a figure of 25/- per house. For a further payment of 11/- a gas connection to a coke burning inset was provided in the living room grate. This resulted in smokeless fuel facilities being available in a large number of new houses. With post war housing it was proposed to improve upon this arrangement by adding a solid fuel boiler as this was the most efficient method of providing hot water in the home and furthermore consumed smokeless fuel. Unfortunately this boiler had been deleted from the Second Contract on the instructions of the Ministry of Health in order to bring down the price of the houses. The Electricity Undertaking was now installing five power points free of cost, presumably as a counterblast to the action of the Gas Company. Thus the tenants had two forms of smokeless heating as the result of healthy competition. Personally he felt the loss of the domestic boiler was serious and seemed to indicate that they were building houses down to a price instead of up to a standard. A lady Councillor from Richmond had asked what could be done with existing houses as most of the talk hitherto had been in connection with post war building programmes. The answer was, of course, that new appliances could as a rule be fitted to existing houses which in most cases would without doubt result in marked economies in fuel consumption coupled with the almost complete elimination of smoke. The fittings would have to be in good supply before this change over could be carried out and further this matter would be the responsibility of the owner or possibly shared by arrangement between the owner and tenants. In this direction, Mr. Marsland stated, lay the way to the economy in domestic fuel consumption desired by the Minister of Fuel and Power.

Councillor J. Duffus (Bexley) regretted that his Council had not yet joined the Society, but hoped to have this rectified in the near future. The previous speaker had implied that the Minister of Health was not prepared to agree to loan sanction for housing schemes incorporating the latest

models of smokeless stoves, owing to the increased cost. Mr. Alderman Charles Key, M.P., had given a definite assurance that the Ministry of Health agreed in principle with the Simon report, and that no scheme would be turned down because of cost of new appliances. The Government had only been in office for a short time and wheels moved slowly, but co-operation by all concerned would ensure the best use of coal and every modern type of appliance.

Councillor Mrs. M. Dale (Wolverhampton) emphasized the fact that if the Smoke Abatement Society was to make any headway it must be realized that efforts must be made to get the women organized. Nothing could be done unless women were convinced that in addition to being a nuisance smoke was injurious to the health of the nation, and their families in particular. She asked what the Society was doing to supply housewives with apparatus and the proper fuel for smokeless fires. On inquiry she had found that whilst the grates were available the fuel was not. She sincerely asked the men at the meeting to convince their own womenfolk of the importance and necessity of smoke abatement.

Councillor J. Cool (Ebbw Vale) suggested that the conference should meet in an industrial area, and said that if they came to Ebbw Vale delegates would soon be finding the time of the next train home or seeking treatment to have grit and dust removed from their eyes. However, new plant at the steel works in the town was expected, when completed, practically to free Ebbw Vale from dust and grit. He hoped that legislation would soon be obtained giving increased power to local authorities.

W. W. Foakes (Chief Sanitary Inspector, West Bromwich) said that the figures given in the West Regional Report on smoke prevention in new houses were very disturbing. The report gave 41% new houses as being equipped with old-type firegrates. This 41% would be added to the already large number of old-type firegrates in use and smoke producing. In view of these figures, one of the largest fuel distributors in the district was contacted, and it was found there was not sufficient smokeless fuel to go round. The demand for smokeless fuel was greater than the supply. The ordinary " coalman " often advised on the most suitable fuel for the domestic firegrates, and an invitation should be extended to the fuel distributive trades to be present at the conference. In many instances the wrong fuel was burned on the domestic grate. Fuel from opencast workings was causing a lot of smoke by burning on the open domestic grate, and often the best coal was issued to the consumer with the poorest type firegrate. There was no selection of fuel. The solution appeared to be the provision of more smokeless fuels, and smokeless fuels should be produced at the " pit head."

Councillor A. H. Chaplin (Holborn) said that as a representative of a neighbouring authority to the City of London he had been interested to hear of the suggestion that the City might introduce district heating for reconstructed blitzed areas. Holborn, and also other much damaged districts, in London and elsewhere, would be glad to have more information about the project. Was it to be applied to land owned by the Corporation, or was it to be a service supplied to buildings or privately owned land ? Were there any means by which a local authority could induce private consumers to use such a service if it were provided ? His own Council were interested in the possibility of district heating in a mixed residential and commercial area. If Holborn were to benefit, when the wind was in the East, from a smokeless zone in the City, it would be a poor return to send smoke into the City on the rather more frequent occasions when the wind was in the west.

Councillor J. Burnip (Easington R.D.) said that smoke pollution was of great concern to his Council in a large coal producing area. A previous speaker had stated that in some parts of the country mineworkers received free coal of Grade I quality. This was wrong because in many parts it is of shocking quality for heating purposes and metallurgically destructive to the open grate fire. In referring to electricity he said that the colliery companies, which supplied the basic product coal, also retailed to their workmen the energy with which they are supplied from the power companies. The snag was that the charges made to the householder were prohibitive for the purposes they were endeavouring to promote in their town planning schemes—devices and equipment to abolish the open coal fire.

C. A. Stansbury (Walsall) said that the Simon Report had indicated some 62,000,000 tons of coal were used in 1938 for domestic purposes, and the Report also envisaged a much heavier demand ; new houses built to-day required space-heating and hot water for washing, baths, etc. Every house built to replace a slum house would require hot water and space heating, and there was a tremendous number of houses in this country occupied by our best class of artisan without any means of providing constant hot water, except from utensils placed on the firegrate or cooker. The occupiers of these houses would soon be demanding constant hot water supplies, it was an amenity that no one would deny them. This would appear to indicate that the demand for heat energy for domestic purposes would show a sharp rise in the years to come. It was all the more necessary, therefore, to make plans now to meet the situation to ensure that every appliance placed in our new houses was the very best that could be obtained from the point of view of space heating, provision of hot water, fuel consumption and smokeless combustion.

Councillor A. J. Ogden (Feltham U.D.C.) said that during fifty years plumbing the damaged caused by smoke had been forcibly impressed on his mind. His Council was installing new types of grates and warming units in their new estates, but the high cost of gas and electric fittings was preventing their use.

Mrs. F. E. Lea (Ministry of Fuel and Power) said she had read with much interest the regional reports summarizing the replies to the questionnaire sent out by the Executive Council and reviewed by their Secretary that morning. She was glad that he added a brief statement of the remarks made by Sir Guy Nott-Bower, Deputy Secretary of the Ministry of Fuel and Power at the recent "Fuel and the Future" Conference. The proceedings of the Conference were, she gathered, to be published and she hoped that the resumé of Sir Guy's remarks would be re-read by those present as it set out what was being done by the Central Government with regard to implementing the recommendation of the Simon Report and what was intended should be done in the future. Supplies of solid-fuel-burning appliances were so short that the Ministry of Health were recently obliged to issue an instruction that except in rural areas, etc., where solid-fuel cookers were installed, only one cast iron solid-fuel-burning appliance should be provided for each house. Any further slow-down of production would jeopardize supplies still more. Now, it was only during the war that many of the improved and efficient types of appliance had been developed and before production could begin new moulds are necessary. The shortage of labour in the iron foundries was desperate and although most of the larger manufacturers had developed improved models, the rate at which they could change from the production of pre-war models to these was necessarily slow. The weekly output was growing, however, and by April or June of next year should become a flood. Local authorities could in the meantime do much to help speed this turnover by demanding the improved appliances and this would at the same time bring pressure on the laggard manufacturers who were content to turn out smoke-producing, inefficient grates so long as their order books were full.

Apart from the contribution that could be made by the increased use of gas and electricity with a parallel decrease in the use of bituminous coal, the main contribution towards domestic smoke reduction must come from the increased use of smokeless fuel as recommended in the Simon Report. In his opening summary of the remarks made by Sir Guy Nott-Bower to local authority representatives at the "Fuel and the Future" Conference, their Secretary quoted Sir Guy as saying that "The National Coal Board have got this problem in the forefront of their programme." In fact Sir Guy pointed out that the vesting date for the National Coal Board was at present fixed for January 1st and that after that time we might expect to be given by the Board some idea of what they expected to achieve in that direction. In the main this increase must come from anthracite or manufactured fuel of which the principal type at present was coke. The total consumption of anthracite for domestic purposes before the war was 1.2 million tons, and the total output $6\frac{1}{2}$ million tons compared with a total output of bituminous coal of about 230 million tons. Total production was now down to $3\frac{1}{2}$ million tons and any increase was clearly unlikely to affect the picture

for the next few years. Increases in the supply of coke depended on the increases in capacity of gas works. The demand for gas was already so seriously straining the latter that coke production had dropped during the war. Significant increases in coke supplies were clearly long-term possibilities—at least they would not happen tomorrow. Lest she seemed to be rather gloomy, continued Mrs. Lea, she might mention district heating which had already been referred to by many speakers. This was an alternative method of forwarding the issue for smoke abatement. A number of schemes had now been approved. They in the Ministry of Fuel and Power hoped there would be many more.

J. W. Young (in a written communication) stated that one of the difficulties in the production of modern smokeless grates was the fact that the Ministry has carried out its negotiations principally with the research committees of the standard firegrate manufacturers' associations. These were essentially made up from the makers of the pre-war type of grate, who tended to work on their old-established systems and manufacturing arrangements, i.e., firms consisting of fine grade cast iron foundries. The bottleneck in foundry work, even before, and much more since the war, was labour of the moulder type and the difficulty of persuading new labour to take up that class of employment.

More scientific manufacturing firms, however, not essentially in the firegrate business, and especially those which had extended or started during the war period had concentrated on more modern methods where mass production was simpler, such as prefabricated mild steel welded construction work, to carry out which, hundreds of work people, both male and female, had been taught sheet metal forming and welding. Many of these people, moreover many sheet metal firms, were at present looking for work, or closing down. Moreover, scientific designs of firegrates had been developed both for fuel economy and for smoke abatement most suitable for that labour and type of manufacture. It was, therefore, obvious that, irrespective of the temporary shortage of steel plate, the various Ministries should concentrate on firegrates of mild steel prefabricated construction, many of which were already designed and awaiting mass manufacture by firms not in the above associations.

The treatment of coal for various utility purposes was never in its initial stages directly intended to produce smokeless fuels. The earlier forms, such as coke-ovens for the steel industry required clean coke for their furnaces, while gas retorts for public utility gas manufacture did not essentially make coke for public use ; both these undertakings discovered much later the value of their by-products. Even high and low temperature carbonization firms had not considered smokeless fuel in their original schemes, and only later produced special smokeless fuels by sacrificing a small percentage of their original products, the hydrocarbons, to produce special coke suitable for burning in coal-burning firegrates. Here again it was obvious that the Ministry should concentrate on coke-burning firegrates and the production of standard gas coke, if possible finding additional markets for the use of the extra gas produced in industrial heat requirements and even perhaps (in the future) gas turbines for electricity supplies, making the gas and coke at the collieries and distributing the gas over the country in a high pressure gas piping grid. If only coke and gas were produced from coal, no problem of smoke abatement would arise.

Dr. Hebblethwaite, replying to the discussion, wished to emphasize one point only. The report of the Durham and Northumberland Smoke Abatement Advisory Committee, for which he was responsible contained one point which had also been mentioned by other recorders and again had been mentioned in the discussion, and that point was in connection with the choice of the open fire. He asked the conference to remember the word choice as well as the open fire. He failed to see why the President, Sir George Elliston, spoke so optimistically about the future in his presidential address yesterday afternoon, after he had run over the events of the last twenty years. Twenty years ago, he attended his first smoke abatement conference at Birmingham. Then, he heard about the danger of domestic smoke caused by the open fire and remembered groups of people at that conference saying "Well, after all, the open fire is best." Throughout the years following that meeting, he had returned from similar conferences after hearing similar expressions of view

and was perfectly certain that there would be members from the present assembly who would return and say that they had heard a lot of new ideas about heating but give them the open fire. He was not impressed, therefore, with optimism regarding the future and envisaged in twenty years' time similar discussions with similar views as to the cheerfulness of the open fire. He was of the opinion that even if gas and electricity was made cheaper and more readily available, even if the solid smokeless fuels were similarly made cheap and available, together with the new grates to burn them, and even if district heating became a definite fact, if the **choice** remained to have soft coal in an open fire there would be no progress. The remedy was simple but so outstanding that it might even appear ridiculous but it was that one factor which was essential if any progress was to be made and that factor was that it should be made illegal for raw coal to be supplied to any householder.

Dr. Martine, replying to the discussion, said that one aspect of the subject struck him forcibly while he was correlating the replies to the questionnaire—the need for educatoin—and education at an early age, for the older generations had shown that they were not a profitable medium for their propaganda. He asked all present to go home and try to get at the older school child and adolescent who join the rank and file of the youth organizations. The Society's booklet "The Smoke Problem and Science Teaching" had been well received and he was convinced that this was the only way to get under the skin of the people.

James Law, replying to the discussion, said that with regard to fuel burning installations in new houses, though this was a subject that should be brought well forward, they had a feeling of frustration with regard to efforts made. "The Housing Manual" and later the "Domestic Fuel Policy" gave them a "buoyant" feeling that they could do so much to solve the problem of domestic smoke : all they had to do was to see the various architects and Housing Committees, and everything in the garden would be lovely. Then they made enquiries from the Fuel and Power people about solid smokeless fuel supplies, from the gas companies about gas supplies, from the electricity departments about appliances and points for heating purposes, and they began to have some doubts about their plans. Finally, they went to the range-makers and asked them about deliveries of suitable fireplaces and possibilities of early delivery and became disillusioned with regard to any early solution of pollution from domestic fireplaces. He was also interested in the progress made with district heating, because he thought that their present method of "space heating" or heating the air of rooms was all wrong. Every time a door or window was opened the whole of that heat was dissipated to the outer air. The most rational way of heating buildings was to heat the fabric, the ceilings, floors and walls, so that the warmth could be stored there, in other words, the "panel heating system."

F. J. Redstone, replying to the discussion, said that Sir George Elliston had said he was an optimist and he too wished to join the President in an optimistic viewpoint for the future, particularly as at the recent "Fuel and the Future" Conference which he had been privileged to attend the need for fuel efficiency had been stressed at every session and this gave him to feel that the demand that fuel be used more efficiently than in the past would no doubt do more for smoke abatement and prevention than all the arguments they had ever put forward on public health grounds. One most important thing in the Society was the power of example. It mattered a great deal what they were preaching to others but what are they themselves practising ? What was the speaker himself doing ? What were those in the body of the hall doing towards smoke abatement ? It was not unknown that local authorities created nuisances with their gas and electrical plants and he was satisfied that the eyes of the people would always be on these things and they must by the power of example set a lead to those they wished to convert. He was able to report a great stirring of interest on smoke prevention in the West of England area covered by the Bristol and District Regional Smoke Abatement Council, and there appeared to be a determination to plan in the future for prevention against atmospheric pollution.

SECOND SESSION

Friday Afternoon, 25th October, at 2.30

PROPOSALS FOR NEW INDUSTRIAL LEGISLATION

Chairman : **Councillor Miss D. E. Stringer**

(Chairman, Public Health Committee, Brighton)

(The draft byelaws submitted by the Executive Council are printed as a separate pamphlet.)

THE FUEL TECHNOLOGIST'S VIEWPOINT

by SYDNEY N. DUGUID, B.Sc.Tech., F.Inst.F., F.R.San.I.

To prevent atmospheric pollution and promote efficiency an industrial fuel-burning plant must be (a) correctly designed and equipped ; (b) adequately maintained and (c) operated by a trained and experienced staff.

The necessity for observing these basic conditions is recognized by all Fuel Technologists and, particularly by those who, for many years have tried, by exhortation, to get them universally accepted.

Any proposals therefore, of a practical nature, that would ensure the observance of these conditions by all owners of fuel-burning plant, ought to be welcomed and supported.

Would the preliminary proposals of the National Smoke Abatement Society, for new legislation, help towards this end ? Unquestionably they would. They are right on the target. If they became law the end of atmospheric pollution by industrial smoke, and also of fuel waste, would be in sight.

The proposals have the virtue of simplicity. They can be understood by anyone, even by those who have only a nodding acquaintance with industrial fuel-burning plant.

As regards New, Altered and Additional Plant (*A* (*i*))

Under the byelaws suggested by the Society, approval of the plans of a proposed new fuel-burning plant, or of major alterations or additions to an existing one, would have to be obtained from the local authority before the work was put in hand. Building plans have already to be submitted to the local authority and to extend the scrutiny to the plant which they may contain would present little difficulty.

Suitable draught with accessible control, an adequate chimney, instruments necessary for controlling combustion, and some arrangement by which the firemen can immediately become aware of smoke emission, would have to be provided. Most modern fuel-burning plant are equipped in this manner and it would be unreasonable to require that older plants should be brought up-to-date, as far as practicable.

It is possible that the above proposals might be welcomed by those concerned, as the local authority would relieve them of all anxiety as to

whether their plant could be operated to conform with the smoke bye laws. Unbiassed assistance of this nature might save much fruitless expenditure, and foster the spirit of co-operation, so essential in these matters, between the owner and the local authority.

Any steam-plant engineer is able to retail instances of ill-advised expenditure and the author could give chapter and verse of many cases where sums up to £350 per boiler have been spent without beneficial results.

These proposals would also encourage designers of plant to place avoidance of atmospheric pollution amongst the principal objects of their designs.

A modern boiler plant which the author once visited was sprinkling the area with so much grit that a man was employed full time, sweeping it up from the roadways inside the works and clearing it from the gutters and downspouts. To abate this nuisance now the plant is at work, would probably entail the expenditure of some thousands of pounds, whereas with a little forethought on the part of the designer it could have been avoided at a reasonable additional cost. If the plans had been checked from the smoke abatement angle the certainty of a grit nuisance arising would have been foreseen, and the necessary provisions made to avoid it.

As regards Maintenance, Operation and Care. (*A* (*ii*)).

With regard to maintenance, operation, and care of a fuel-burning plant, the proposed byelaws Nos. 8, 9 and 10, insist upon the plant being kept in good working condition, that heating surfaces and flues be kept clean, and that overloading to such an extent as to cause smoke and grit emissions, shall not be indulged in.

These requirements are in line with modern practice and no fuel technologist, or plant engineer, would criticize them adversely.

As regards registration of Boilers, Furnaces and Firemen. (*A* (*iii*)).

Under the above proposed new sub-section only trained men would be allowed to operate fuel-burning plant which required skilful and experienced handling to prevent air pollution.

The local authority would keep a register of such plant and the firemen or operators would be licensed.

The importance of this proposal cannot be exaggerated. Those closely associated with fuel-burning plant, have, for a great many years, recognized the fact that the operation of such plant demands the services of skilled and experienced men. The men on the firing floor can make or mar the running of any plant however well designed and equipped. Thorough training is essential.

This proposal would benefit the fireman by raising his status and the owner would have the satisfaction of knowing that his plant was being run by competent men.

Any local authority, or group of authorities, deciding to adopt this proposal would naturally ensure that suitable courses of instruction, for the men they proposed to licence, would be organized. The means are already at hand. Local authorities have control of technical schools and also possess a variety of fuel-burning plant at their electricity works, gas works, water works, baths and hospitals, which might be used for practical instruction. What better facilities could be found, or devised,

for training operatives and any others, concerned with the matters under discussion ?

Observing a chimney top, stop-watch in hand, and an occasional prosecution will never solve the smoke problem although they may do something to curtail it.

These new proposals are drastic and far-reaching, but practical, They do not go beyond the bounds of technical possibilities and, if universally adopted, we could look forward, with certainty, to the time when industrial smoke and fuel waste would be just a memory of the bad old days.

THE SMOKE INSPECTOR'S VIEWPOINT

by GEORGE W. FARQUHARSON,

Senior Smoke and Factories Inspector, Birmingham.

By these proposals submitted for general discussion by the Society we are starting on a new chapter in Smoke Abatement history, with the main object still in view of removing as far as possible the ill effects suffered by the ordinary citizen, especially those who live in our large industrial areas.

Now that the Government and Local Authorities are engaged in reconstructing the fabric of civilian life in such matters as new towns, re-distribution of industry, health services and housing, etc., surely in this changing pattern a place should be found for measures that will promote those essential commodities of life—sunlight and pure air.

Whatever the defects of these proposals, they do provide a basis to work from, and from an Inspector's point of view they fill in certain gaps in National legislation which in the main will prove beneficial to all.

The foreword to these proposals states they are to be regarded as provisional, therefore, the question whether such provisions come within the scope of existing powers to make byelaws under Section 104 of the Public Health Act, 1936, or whether it will be necessary to promte an Amendment Act, is a matter for legal opinion, but in my view a special Amendment Act will be necessary.

Now let us consider the proposed byelaws, as regards new, altered and additional plant (A(I)), Para. 1-7. The principles involved here are commonly known as " prior approval," or prevention is better than cure, and one must agree it seems common sense to endeavour to ensure good combustion conditions at the firegrate end, than to deal with the installation or chimney as a statutory nuisance should that event arise. Prior approval of new fuel burning plant is being carried out in a minor form with good results in several large industrial cities at the present time. The method of procedure is for those engaged on smoke prevention to approach the owners or architects who submit plans of industrial buildings and chimneys for approval under the building byelaws ; the object being to persuade those responsible for the new installations to instal the most modern equipment possible, and also to ensure that the chimney stack will be a reasonable height compared with the surrounding buildings.

Another form of prior approval is also being operated by Local Authorities concerned with re-development and reconstruction ; this is done by means of a clause in tenancy agreements, when land owned by the local authority is being re-developed for industrial purposes ; some private trading estates also have similar covenants in their leases for factory premises.

Regarding Maintenance, Operation and Care. (*A* (*ii*)), *Paras.* 8-10.

The first thing to note is that these paragraphs deal with existing plant. They are in a degree supplementary to Section 101, para (I) of the Public Health Act, 1936, which deals with any installation for the combustion of fuel, and which does not as far as practicable, prevent the emission of smoke into the atmosphere, subject to the qualifying clause Section 109, and by carrying out the principles under this heading the owner would, in effect, be using the best practicable means to ensure efficiency and good combustion of the fuel in use, and also of providing for the maintenance of adequate and proper plant.

As regards Registration of Plant and Licensing of Firemen. (*A* (*iii*)).

I see no difficulties regarding the registration of certain plant, but the question of Licensing of firemen or furnacemen to operate these registered installations is, in my opinion, a most controversial subject. Working conditions, grades of fuel, different peculiarities of similar plant, vary so widely in the industrial field, that in granting a license to any fireman or furnaceman possessing the necessary skill and knowledge in the firing and operation of any specific installation would not guarantee that the same person could operate a similar installation in another works without making smoke.

On the question of revoking or suspending such a licence. I think such extreme measures as to interfere with the rights and privileges of a man to earn his livelihood as a fireman or furnaceman will by no means help the cause of smoke abatement. Granted these proposals allow for an aggrieved person to appeal to a Court of Summary Jurisdiction, but, in the meantime, until the appeal is heard that aggrieved person cannot, according to the proposals, carry on his job of firing or operating the registered plant, except under a penalty not exceeding five pounds.

Another point in these proposals is the lack of provision made for a person to start being a fireman or furnaceman. He may have the necessary knowledge, but, as a beginner he cannot possibly have the skill or experience. Therefore, provision should be made for supplementary or beginner's licences.

Conclusions.

I think the principles relating to prior approval and maintenance are worth while pursuing, but I don't agree with the licensing of personnel. I feel it is the obligation of the owner of the plant to see that he employs the right type of man, and to give him good working conditions as regards adequate and well maintained plant, together with that important point of all good fuel.

On the question of the byelaws themselves, it is recognised that any byelaws must not conflict with the Act under which they are made, therefore, that so-called exemption claimed by the steel trade, collieries,

and clay industries will need further clarification; otherwise these bye laws will be appertaining only to boiler plants, and finally it would appear that private sea-going vessels, whilst liable under Section 267 of the Public Health Act for prosecution for the emission of black smoke from the funnel, would be exempt from any type of byelaws, by virtue of paragraph 4 of that section.

THE STOKER'S VIEWPOINT

by ERNEST BOWLES.

I am greatly interested in the proposals placed before this conference for two reasons. I am employed in the greatest coal processing industry and live in one of the largest industrial cities, Birmingham. The subject of smoke abatement is therefore one in which I am particularly interested, both as an employee and as a citizen of no mean city.

The emission of smoke into the atmosphere is a sign of incomplete combustion and indicates a waste of the country's wealth. One of the most serious aspects of smoke emission is atmospheric pollution. The important task before us is to see how far the dust and sulphur compounds in the flue gas can be prevented from issuing into the air.

The actual damage done runs into several millions of pounds per annum. In the old fashioned domestic grate little more than ten per cent. of the potential heat of the coal is usefully employed and clouds of smoke are produced. The industry in which I am employed has, by utilising the smoke and fumes, instead of letting them go up the chimney, played an important part in the domestic sphere towards smoke abatement. In all cases in the industrial field where coal is used with a low efficiency, I submit that gas would provide a desirable alternative.

Dealing with the question of industrial smoke abatement we all pay our tribute to the technical development in this direction which is evidenced in the larger factories. Unfortunately some of the smaller industrial concerns are not so up to date,

Progress lies in careful control and efficient supervision of plant. The proposals submitted for your consideration are a definite step in this direction and, speaking as an operative, I find myself in complete agreement with most of them.

I am certainly of the opinion that a survey should be taken of all fuel appliances by competent people, appointed by the local authority, who should have power to see that coal is not burnt in a haphazard fashion.

Whilst appreciating the penal clauses of the proposals I think these in themselves are not enough. Competent instruction should be given

by technicians on this important point. All fuel burning appliances should be registered with the local authority and subject to examination from time to time.

I think also that boiler houses and other buildings, where fuel appliances are installed, arrangements should be made whereby the stoker could see at a glance the smoke that is being emitted from the chimneys. I may say a word here to the technicians, I would suggest that they apply their mind to the question of ensuring complete combustion where the burning takes place as this appears to me to be more important than dealing with the smoke after it has been created.

A definite step to the end we seek to attain could be achieved by ensuring that the right type of man is employed as a boiler attendant. I do not believe in the principle of registration as it appears to me to be a still further encroachment on the rights and liberties of the individual. I think this object could be achieved by insisting that in all our industrial agreements the stoker's job is definitely graded with an attractive rate of pay. This already operates in most of our principal industrial agreements. I think also that a fireman or furnaceman, holding as he does a very responsible job, should have had a proper period of training under a qualified man before taking over responsibilities, and should not have additional duties placed upon him which should take him away from the boiler house or furnace at periods to do other classes of work.

I feel confident with the technical developments which are taking place in the country to-day, proper legislation to ensure supervision of all fuel burning appliances, legislation to deal in a proper manner with people who deliberately break the law and with the development of the right type of personnel to take charge of fuel burning appliances, that we shall succeed in our object to change the black streets and black and grey skies which are depressing and unfortunately universal in British industrial towns.

THE INDUSTRIALIST'S VIEWPOINT

By H. A. Humphrey, *M.I.C.E., M.I.Mech.E., M.I.E.E., F.Inst.F.*

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Introduction.

Following an inquiry of the National Smoke Abatement Society to industrial circles it was suggested that the author should prepare a paper giving his views as an " Industrialist " on the legislative proposals contained in the Society's pamphlet "Industrial Smoke Prevention Proposals." The Society then issued an invitation to the author to give a paper on the lines suggested and mentioned that the Society was anxious to have any criticisms or alternative suggestions.

The author has therefore assumed that the invitation includes the consideration of alternative proposals designed to attain the same ends but by a much more practical and effective method of procedure.

He believes that the occasion is opportune to bring together those ideas which he shares with the leaders of Industry and which may be expected to produce the maximum smoke abatement in the minimum time.

The present paper has therefore been written to put on record those far-reaching legislative proposals which Industry is prepared to accept in order to prepare the way for the enforcement of regulations leading to the highest practical standards of smoke and dust elimination.

Requirements for New Legislation.

Leading industrial firms have already, by research carried out by their own staffs and by the work of their Research Associations, made possible very important progress in the scientific combustion of fuel and in combustion appliances. The result has been a greatly improved fuel economy and, since an increased economy is accompanied by a diminution of smoke production, Industry has been the chief contributor to the solution of the Smoke Abatement problem. The advances made in fuel efficiency have been fully recorded, under industrial headings, in the sixteen papers read and discussed at the Joint Conferences of the Institute of Fuel and the National Smoke Abatement Society held in London, Manchester, Doncaster and Nottingham in 1945 and 1946. They show clearly that these advances originate internally and are the result of a continuous progressive policy. In other words, Industry is leading the way in Smoke Abatement and is the best advocate of the movement.

Industry is not averse to legislation on the subject provided it is realistic and based on what is practical and reasonable. In fact such legislation is welcomed by Industry as being the only way of ensuring that the small backward or selfisfih minority, which exists in any section of the community, is compelled to conform with practices which the vast majority of industrial fuel consumers will have voluntarily adopted in the common interest. But the qualification that the legislation should be realistic and based on practical and reasonable considerations is all-important, for ill-considered legislation can lead to disaster in one of two ways. If the regulations are enforced, then great injury can be done to the capacity of this country to produce ; and increased production is essential if we are to remain a first-class Power. If the regulations are not enforced, then the door is thrown wide open for evasion of all kinds.

It is essential, however, that all such legislation should be administered in a competent but co-operative and sympathetic manner, so that the manufacturers will regard the inspectors and others responsible for enforcing the regulations as friends trying to help them with their smoke-production problems and not merely as officials whose sole object is to secure convictions.

This paper will show that the framing and administration of regulations for smoke control, which can be regarded as constructive and reasonable, bristle with very difficult scientific, technical and economic problems. It is therefore necessary to make it quite clear that, if there is to be legislation of this type, then Industry will require that it is

framed at the highest level with the assistance of the best available experts. Its administration must be controlled under the Ministry of Fuel and Power. All matters relating to Standards, tests, and approval of appliances must be decided and defined at the level of the Government's Fuel Research Station, the Department of Scientific and Industrial Research or a special body appointed for the purpose.

There is nothing in all this which reflects on Local Authorities, as such, but it is in keeping with the strong tendency to transfer their powers to more central organizations better equipped to carry them out. Thus twelve powers formerly exercised by Local Authorities have been, or are in process of being, taken away from them. The list starts with the Licensing of Passenger Road Services in 1930, includes Police and Fire Services, and may end with the nationalization of Municipal Gas and Electric Supply undertakings. We are passing through a period in which Local Authorities are losing control of those services which necessitate their maintaining highly qualified and specialized technical staffs.

Classification of Smoke.

We may divide smoke into two broad classifications :—

(a) Black or brown sooty and tarry matter.

(b) Fine dust and sometimes also coarse grit from processes where combustion is substantially complete.

In some cases, e.g. from cement kilns, most of the dust is not due to the ash in the fuel but to materials entering or leaving the main process. We shall exclude from consideration here the dust omitted from a few specialized processes such as certain mineralogical and metallurgical processes which in any case are highly localized and do not affect the real problem as it concerns the country as a whole.

Cause and Prevention of Sooty Smoke: Its Relation to Quality of Finished Product.

The ordinary dark or black smoke emitted from chimneys is due to incomplete combustion of the fuel, usually because of too great cooling of the flame. Under steady load conditions and over quite a wide range of load, no smoke of this character should be evolved from large oil or coal fired furnaces for raising steam. Some smoke is perhaps inevitable when starting up from cold if no auxiliary gas burners are available, but the usual cause of this type of smoke is either bad design, uneven firing, or substantial overloading, e.g. during sudden demands for steam.

Consequently, in normal furnaces in which coal is burnt, smoke can be avoided by adding fresh fuel in such a way that the tarry volatiles evolved are consumed by passage over or through red hot fuel or past red hot refractory (brickwork) always provided that there is sufficient excess air left in the flue gases to burn them. In boilers this is done by mechanically stoked furnaces such as the travelling grate with refractory front arch or by the underfeed retort stoker but it can also be done by careful hand firing. But for certain metallurgical or ceramic processes, slow heating under reducing (i.e. air deficiency) conditions is necessary : smoke cannot then be completely avoided, though in some cases furnaces are being evolved in which some of the smoke is being consumed by

the addition of hot secondary air at the back end. The solution for some of these processes may be the use of gas or coke firing or of electric heating, though often at higher cost.

Unfortunately coke will not always produce the required conditions (of temperature or atmosphere) in furnaces so far devised and neither will gas. (A particular example is in the production of certain qualities of high grade burnt lime—neither coke nor gas firing will give the quality that can be obtained with coal). On the other hand, gas and electric furnaces have been devised for some processes which give a better product or are so much easier to control that their higher running cost is offset by their advantages. The quality and price of the finished product remains, however, of paramount importance—most manufacturers are constantly striving to improve the quality of the products and obviously production managers will not instal types of furnace, however smokeless, if they are going thereby to lose the market for their goods, nor would any Government force them to do so. In short, the chemical and physical changes that occur in some manufacturing processes must be taken into account when we talk of carrying out those processes smokelessly.

The question then arises—can the sooty smoke particles once formed be removed in some form of mechanical eliminator similar to the devices used to remove dust. Unfortunately, with present knowledge this is not practicable on a continuous industrial scale even with very expensive equipment—the reason being that the smoke particles are either extremely fine or are so light and fluffy that they cannot be caught by devices so far known.

Those smoky processes which under present knowledge cannot be economically replaced by smokeless processes without sacrifice of quality of finished product should therefore be the subject of continuing research. Alternative processes and furnaces should be studied as it is doubtful if it will ever be cheap to remove from final (chimney) flue gases the particles which go to make up sooty smoke.

Measurement of Smoke Density and of Dust, etc.

Past legislation has only referred to the emission of black smoke from chimneys attached to specified processes and to the taking of the best practical means for preventing a nuisance due to grit and dust etc. It has neither defined black smoke nor best practicable means. No Smoke Inspector can work efficiently with such ambiguous phraseology nor can the designer of new plant.

During the past ten years or so, photoelectric cells have been developed for use on industrial plant and it is now possible to install a device in a chimney which will continuousy record on a chart the actual density or light obscuring power of a smoke or dust and even sound an alarm when a set limit of obscuration is exceeded, for example 50% obscuration of light in a 10 ft. column.

The determination of dust emission from a plant has been covered by British Standard Specification 893. The procedure is so complicated, however, that, with very few exceptions indeed, dust extraction plant is only tested for performance by its manufacturer and then only for an acceptance test. Under such conditions, all the plant is new and it is

run under the best possible conditions. Most boiler plants, even at large Power Stations, are neither staffed nor equipped for making regular routine tests to determine whether their dust arrestors are in need of adjustment. Sometimes increased dust emission is due not to the deduster but to the quality or quantity of dust in the gases fed to it.

Plants burning over 1,000 tons/day of coal can well afford to make routine tests but some simplification of the procedure of BS.893 is required for such tests and it is to be hoped that the B.S.I. Committee concerned will issue immediately an interim note or addendum to the specification giving guidance on the matter. These Committees work slowly in the preparation of detailed specifications, but the subject is one of some urgency and one in which the experience of industry of tentative methods would be valuable to the Committee.

One drawback to existing methods of test is that dust burden is not uniformly distributed across the section of a flue nor is the gas velocity uniform. Simple mixing baffles are, however, capable of design which can be inserted in the gas stream when tests are in progress and removed or turned out of the way when not in use.

If sampling were to be carried out at one point, automatic samplers could be devised which would collect a fair and proportionate sample of the dust being discharged to the chimney and measure the gas volume. With this form of apparatus in regular use, measurements would be obtained of the dust discharge under normal operation conditions and not merely when the personnel are running their plant under the best possible conditions. The necessary development of the apparatus should be a high priority at the Fuel Research Station, an accuracy of 85-90% will be quite sufficient. Probaby the apparatus will still not be suitable for short and twisting flues ; new boiler plants should have their flues laid out so that testing for dust emission is made simple.

The process of testing is too complicated and involves too much equipment for the tests to be made by any Smoke Inspector, but a step forward in ameliorating conditions would be taken if Large Scale Industry were made to carry out tests by an approved method at regular intervals and disclose their results to responsible centrally controlled officials. As interpretation of figures is not always easy, the figures should not become the property of Local Authority Councils as they have not the trained staff for a technical appraisal and comparison of the results. Industry would probably be perfectly willing to co-operate under these conditions—it is, however, averse to allowing its operating figures to become the subject of local debate and local politics. An immediate start might well be made with all public utility (public and privately owned) Power Stations, who are, after all, under some jurisdiction by the Electricity Commissioners, the body which has already issued general instructions but never followed them up by examination of performance. An annual or biannual performance test on each individual unit (before and not immediately after routine overhaul) would give the management sufficient information on the performance of their plant and would not be out of step with ordinary routine production efficiency measurements.

Appointment of Smoke Control Officers.

When the Government proceeds with further legislation on smoke

control, the framing of regulations should, as said in the introduction, be a matter for Central Authority. This argument is also reinforced by the success of the centrally controlled Alkali Inspectorate which all will admit have been and continue to be friends of Industry in the design and operation of plant to reduce the emission of certain chemical fumes below limits specified by law. The Alkali Inspectors are men of the highest technical qualifications and they have all had considerable experience in Chemical Industry before appointment. Manufacturers can not only rely on them for technical assistance, even sometimes to the extent of research in the Inspectorate Central Laboratories, but they also know that their own commercial processes and policies are kept secret. Finally, there is the tradition that the Alkali Inspector only initiates prosecution as a last resort and in fact one can infer from perusal of the Chief Alkali Inspector's annual reports that he regards as a good year one in which there have been no prosecutions.

The author would therefore suggest here that the Government appoint a centrally controlled Smoke Control Inspectorate consisting of a few highly qualified combustion engineers working under the Ministry of Fuel and Power. This Ministry has already a central Fuel Efficiency Committee with its Regional Engineers and it may prove possible to combine the duties of Smoke Control Officers with those of the Fuel Efficiency Engineers, choosing men who would administer the central regulations sympathetically though firmly.

Sources of Smoke.

Let us now consider the major sources of smoke in turn and outline some proved methods whereby the smoke can be reduced to negligible density and the dust emission to relatively harmless quantities, always bearing in mind that we must not ask for too much nor expect perfect conditions to obtain at the stroke of a pen and that general comprehensive regulations cannot be made to cover all types of industry.

It is convenient to divide the sources of such emission into the following nine groups, all of which were discussed at the 1945-46 Joint Conferences with the Institute of Fuel.

(1) Power Stations and the larger industrial boiler plants using water tube boilers.

(2) Smaller industrial boiler plants, including collieries, which use shell boilers.

(3) Railways.

(4) Oil burning equipment.

(5) Gas Works and Coke Ovens.

(6) Iron and Steel Works.

(7) Cement and lime burning kilns.

(8) Clay Industries, in particular the Potteries.

(9) Domestic.

The attached table gives figures for the consumption of coal by these industries in 1938 and 1945.[1, 2 & 3]

ANALYSIS OF INTERNAL COAL CONSUMPTION FOR 1938 AND 1945

	MILLIONS OF TONS			
	Year 1938	% of 1938 Total	Year 1945	% of 1945 Total
Collieries	11.9	6.6	10.6	5.9
Gas	18.2	10.1	21.0	11.8
Coke Ovens	19.1	10.6	20.0	11.2
Electricity	14.9	8.3	23.5	13.2
Railways	12.5	7.0	14.9	8.4
Iron and Steel	11.6	6.4	9.5	5.3
Engineering & Metal Trades......	7.2	4.0	4.0	2.2
Cement	11.0	6.1	5.8	3.2
Potteries	1.1	0.6	1.1	0.6
Other Industries (approximate)	24.8	13.8	19.5	11.0
Domestic Bituminous Coal	47.7	26.5	34.6	19.4
,, Anthracite			2.3	1.3
Miscellaneous			11.6	6.5
Total Inland Consumption	180.0	100.0	178.4	100.0

Qualities of Coal Obtainable.

There was a time when a large coal user could order coal of any required quality and be sure of regular supplies. He could thus control calorific value, chemical analysis, volatile matter and caking properties, ash, moisturs, size and mechanical properties. Under these circumstances fuel and combustion appliances could be scientifically adjusted and the plant tuned up to the highest efficiency.

To-day, coal distribution is so arbitary that many firms must accept any kind of coal sent to them and, while these regrettable conditions remain, smoke abatement regulations should be withdrawn rather than extended. Sympathy may be given to the Minister of Fuel and Power in his difficult task but meanwhile a heavy load of anxiety and worry is placed upon Industrial management. Improved methods of allocating coal to consumers according to desired quality are being worked out, but, before they can be effective, it will be necessary for the Ministry of Fuel or the Coal Board to classify the types of coal marketed into a perhaps large but still limited number of qualities and sizes. This is a big task, but until it is completed and a new system of marketing coal by quality is in effective operation, industries buying new coal consuming plants will not be able to specify exactly what coal the plant will receive, and hence no prediction can be made about the smoke producing characteristics of the plant.

From these remarks it follows that there would be many advantages in placing the Smoke Inspectorate under the Ministry of Fuel and Power, since they would then be in a better position to discuss with their colleagues on the fuel supply side steps which can be taken by a manufacturer, especially a manufacturer building a new plant, to avoid smoke

emission. Moreover, if raw materials are equally available, industries from which it is difficult to control smoke emission should be encouraged to expand only in areas where the type of coal gives least smoke.

Reasoned Proposals for Regulations Governing Various Industries.

The following proposals are considered to be practicable as additional steps in Smoke Control Legislation and, as such, the author believes that they would be generally acceptable to Industry.

(*a*) *Registration.*

We already have so many authorities concerned with the running of industry and the erection of new factories that one hesitates to suggest yet another registration. At the present time, however, every coal and oil consumer has to apply for supplies ; consequently it is suggested that all that is necessary is for the Coal and Oil Fuel Supply Officers to register all consumers of more than say 25 tons/week of coal or oil with the "Regional Smoke Control Officer," giving him bare details of the quality and quantity of fuel which is required for full output of the factory, classified according to process and details of what he expects to supply.

(*b*) *Location of Industry.*

Although the Government is doing something towards the more careful siting of industries, it does not, as far as is known, take into account the contours of the land which can so often cause smoke from even high chimneys to be carried down to ground by wind eddies[4, 5]. Nor is it always realised by our Town Planners that the rarest wind of this country is almost without exception from the south-east and hence that the smokier industries should be located in the south-east part of the area concerned. Reference has already been made to the matter of suitable coal supplies.

Smokeless Zones.

Smokeless zones have been mooted for some cities in particular by the Manchester Corporation. Unfortunately, as the Leicester Survey shows[6], the average reduction in smoke at the centre of a square mile quite free from smoke emission would be only 25-30%. The conclusion from the Leicester survey and from measurements made in Hyde Park, London, would seem to be that such zones are no real solution to the problem of the large smoky town and that the only remedy is by drastic reforms in methods of burning raw coal.

(*c*) *Approval of Plant.*

Industry is opposed to the suggestion that individual items in every new factory should be approved by any central or local government authority. The procedure causes endless delay and unnecessary expenditure, overloads the officials and tends to discourage advances in design. It also tends to throw the responsibility for any poor performance of new plant on to the approving authority. It is "smokeless operation" that is required and this can be far better obtained by building the plant to a required specification of smokeless performance—the onus for smokelessness is then placed on the designers and operators. Suggestions are, moreover, made later for certain smokeless types of design for particular operation such as steam raising—these suggestions refer to general

approval of types by the Central Inspectorate and generally speaking would involve only this Central Inspectorate and manufacturers of firing equipment.

Builders and designers of new plants should, of course, not be precluded from asking the advice of the Smoke Control Officers on the suitability of equipment they proposed to install, but the onus must not be put on the Inspectorate if a particular apparatus does not give the hoped-for results.

(d) *Height and Number of Chimneys.*

Following on a report of a special committee[4], the Electricity Commissioners have advised that Power Station chimneys should be at least $2\frac{1}{2}$ times the height of the highest adjoining building with an additional allowance, where necessary, to compensate for down draughts caused by the contour of the land. The advisory committee assumed that if the chimney was sufficiently high, the discharge would be unaffected by down draughts caused by neighbouring buildings and ground contours, and that the flue gases would be discharged into a horizontally flowing stream of air. This suggestion does not take into account the mixing of streams of gases by eddy diffusion. Bosanquet has shown[7, 8] that the flue gases spread out in a cone of about 20° solid angle. Hence they will reach the ground about 10 chimney heights away from the base of the chimney, though greatly diluted. With large Power Stations, however, the mass of dust reaching the ground by this means is appreciable, particularly from powdered fuel installations equipped only with simple cyclone dust arrestors.

A recent study of the uplift effects of the hot gases from chimneys has shown that there are great advantages in the discharge of the flue gases from one chimney as compared with several chimneys—this follows from the reduced cooling effect of the ambient atmosphere on the gases when they are in one stream. Hence engineers should design for one high chimney (or at most two, allowing for maintenance) for every new or extended installation. This is a change from the practice 10-20 years ago, of installing batteries of relatively low chimneys at each boiler house. A minimum height of 250 ft. for Power Stations is also desirable to get above low " inversion " layers and because at this height there is always some wind[9].

The advantages of high flue gas velocity at the mouth of the chimney are discussed in Reference 10, where it is concluded by experiments with models that a velocity up to 60 ft./sec. is desirable.

Industry generally would welcome clear guidance from the Government on heights and numbers of chimneys, and though precise regulations cannot be laid down to cover every case, guiding rules can certainly be formulated. The low chimney which belches smoke and dust down on the surrounding ground should never be allowed to be erected, and steady pressure should be brought to bear on existing offending chimneys based on commonsense visual observation and not on complicated tests for smoke concentration at ground level which are difficult to devise and interpret.

Local Authorities have already some powers on the erection of chimneys which we need not discuss here. It is suggested additionally that the Central Smoke Control Inspectorate should have power to define the height and possibly the maximum number of chimneys to be installed first on steam raising plant and later, after experience, on other types of plant. The following regulations are put forward for consideration :—

(i) That Local Authorities immediately send plans for new chimneys to the Regional Smoke Control Officer for comment as to number, height and position relative to the contour of the ground and juxtaposition to other buildings and domestic houses.

(ii) That chimneys of new boiler houses consuming over 1,000 T/day of coal at full load should be at least $2\frac{1}{2}$ times the height of the highest adjoining buildings with a minimum of 150 ft. above the height of the adjoining buildings. If the Smoke Control Officer has reason to believe that the contour of the land or nearby buildings would cause serious down draughts of the flue gases and residual smoke, he should have power to demand of the designers (but at least three months before construction starts) that tests are made with a model in a wind tunnel or with " no lift " balloons (as recommended in Reference 4) to determine and decide upon the minimum practicable height of chimneys desirable, having full regard to economic considerations.

(iii) That chimneys of new boiler houses consuming coal at a maximum rate of 100 T/day should extend at least 50 ft. above the height of the adjoining building and that there should be a uniform sliding scale of larger plants ending with, say, 150 ft. above the height of the adjoining buildings for plants consuming 1,000 T/day coal.

(*e*) *Compulsory Installation and Use of Measuring Devices.*

It is proposed :—

(i) That, after a suitable preparatory period, all new chimneys taking the flue gases from banks of boilers requiring on full load more than say 10 cwt. total per hour of coal or oil should be equipped with a photoelectric smoke density recorder and alarm, which must be kept in continuous commission when firing is in progress, and the charts for which must be available for inspection by the proposed Regional Smoke Control Officer.

Smoke which gives over 50% light obscuration on a 10ft. column might be considered offending and penalties should be enforceable against persistent offenders.

As improved methods of combustion in boiler furnaces are devised, this regulation might well be extended to still smaller industrial boilers and might be made more stringent for larger units installed after a given date.

(ii) That, when simpler and perhaps semi-automatic testing gear has been devised for dust, as suggested in a previous section, tests are made annually by the owner (under full load conditions and with normal fuel supply) of the dust concentration leaving every dust catcher installed on boiler plants consuming more than say 20 tons per hour of coal. If the plant has soot blowers, these must all be operated normally during the period of

a test. The Smoke Control Officer should have power to demand that adjustments are made and the plant re-tested if it gives an exit dust concentration 20% higher than the previously recorded lowest figure under substantially the same operating conditions. He should have power also to demand further tests and adjustments up to a maximum of, say, 4 per year on each unit when he has reason to believe that increased amounts of dust are falling on to the neighbourhood from the chimneys receiving the flue gases from these dedusters.

The Smoke Control Officer should have power to demand that any test he requires is carried out within a week of receipt of his request subject to the proviso that not more than say two tests in a week are required to be made in any one boiler house.

(iii) That, after experience has been gained on the working of these regulations for boiler plants (and of suitable improvements made in the light of experience) similar regulations, modified to suit the case, should be gradually introduced by the Smoke Inspectorate for other industries, progress in regulation being always governed by progress in research and development of furnaces and devices which emit less smoke and dust to atmosphere.

(*f*) *Consideration of Individual Industries.*

(*i*) *Power Stations and Other Large Steam-Raising Plants.*

The smoke problem here should not be one of emission of dark coloured and sooty smoke but of emission of grit and especially of fine dust. All large steam production factories use water tube boilers with automatic stokers. The combustion chambers are designed to consume all the volatile constituents of the coal which produce unpleasant sooty smoke and the only excuse that can be offered for the production of this type of smoke from such installations is overloading. But with properly designed plant, provided with steam accumulators, even colliery boiler plants and steel rolling plants which are subject to frequent intermittent peak demands for steam can be made quite smokeless. There is, therefore, no reason why firm regulations should not be made penalizing the production of black or dark brown smoke by owners of certain scheduled plant brought into commission after a certain date, and similarly why unsuitable plant should not be banned or modified after it has reached a certain age, say 25 years.

There remains the nuisance arising from grit and dust, which is by no means negligible. A big step forward was taken just before the war when the Electricity Commissioners advised designers of new Public Utility Power Stations that the exit dust concentration discharged from new boiler plant should not contain more than 0.4 grains of dust per cubic foot of flue gas (reduced to N.T.P.) of which not more than 0.15 grs./ft.^{3} should be over 20 microns. (A 20 micron dust particle only settles at the rate of one inch per second in still air and the natural turbulence will therefore prevent its settlement within perhaps miles of a high chimney ; it is however carried down to ground by eddy diffusion). These dust concentrations are relatively high for a large Power Station and some design engineers are specifying exit dust concentrations as low as a total of about 0.15grs./ft.^{3} at N.T.P. for the most modern large Power Stations[11] fired with pulverized coal. There is, however, no

evidence that the high standard of performance involved has been maintained over several years of running.

The great advantage of this voluntary regulation is that at last a move has been made away from the concept of percentage efficiency removal of dedusters (if installed). The concentration of dust passing forward with flue gases from a boiler fired with powdered coal may be ten times greater than that from a stoker fired boiler working at an easy grate rating, and thus 90% removal of dust in flue gases from a powdered fuel boiler would give worse conditions than only 50% removal of dust from the flue gases from many stoker fired boilers.

One weakness of the regulation as proposed is that it does not take into account the size of the installation. A plant burning 1,000 tons/day of coal and emitting 0.4 grs. of dust per cubic foot of gas discharges roughly 11 tons/day of dust into the atmosphere. If, therefore, this plant is doubled, the nuisance it causes to the neighbourhood is doubled even if the same high efficiency of dust extraction is maintained. Obviously the mammoth Power Station must spend on better dust extraction plant a portion of the economies obtained in concentration into such a large unit. (As an extreme case, this was demanded at the instigation of the London County Council when the Electricity Commissioners laid down regulations for both dust and sulphur dioxide removal from Battersea and Fulham Power Stations). Conversely, the relatively small unit should be allowed more latitude—but only up to the limit of well designed simple dust extration plant. Thus, whereas the small user can obtain a clean looking and substantially innocuous chimney discharge by the use of **properly run** simple cyclones, the large user of powdered coal must resort to more efficient means of dust removal such as electrostatic precipitators. Despite the difficulties, it should nevertheless be possible to frame regulations limiting the exit dust concentration from all groups of water tube boilers having a maximum burning capacity of over 100 T/day of coal to 0.4 grs./ft.^{3} of which not more than 0.15 grs./ft.^{3} may be over 20 microns in size, with the additional proviso that the total discharge of dust from any group of boilers under the same ownership and within a given area of so many acres shall not exceed, shall we say, 1,000 lbs./hr.

It is believed that design engineers would welcome guidance on these lines—this class of industry has always been willing to co-operate on reduction in atmospheric pollution but has wanted clear and practicable instructions which are fair to large and small units and fair to the population in the surrounding area.

(ii) Small Boiler Plants, e.g., those using Shell Boilers.

The small boiler plant in heavily industrialized areas such as Lancashire and the West Riding of Yorkshire is, after the domestic house, one of the worst sinners in polluting the atmosphere, particularly in the North and Midlands. The smoke is readily seen because high chimneys are used to provide the necessary natural draught. Probably 20% of the coal in the country is burnt under such conditions.

The hand fired boiler is the cause of most of the trouble—firemen can and should be trained, but much of the training is wasted because there is no automatic recorder to tell the fireman and his management

when black or dark coloured smoke is emitted and for how long ; the temptation to bad firing by the lazy or very busy man therefore remains. There should be practical training accompanied by the bare essentials of theoretical training for the "hand-fireman" and employers and trade unions should be encouraged to work out an improved rate for men who pass courses approved by the Ministry of Fuel on hand-firing, with a points bonus for those who keep their chimney discharge below any limits set by the Smoke Control Inspectorate.

As regards further regulation, the first step should be to ensure that all new plants installed after a given date are reasonably smokeless except under condition of gross maloperation. No firing equipment can be completely fool-proof but just as the Motor Trade was compelled to fit both four wheel brakes and traffic indicators on all new vehicles after specified dates, so improved devices can be made compulsory in the "steam raising industry." Also clearer guidance should be given to Industry on the best practicable apparatus which can be installed to consume smoke as a clarification of the Public Health Act of 1936 which has never been worked properly for lack of definitions. Here are suggestions for first steps :—

(1) That after a suitable period of notice, all new boilers firing fuel of over 30% volatiles[12 (and Cf. 13)] and of rated capacity over 6,000 lbs./hour, should preferably have automatic smokeless stokers or otherwise be compulsorily fitted with a suitable device (see later) for smokeless combustion of a design which has been approved by the Smoke Control Inspectorate. This regulation should also apply to old boilers removed into any new position.

(2) That after a further period of notice, regulation (i) should be extended to all boilers of capacity over 3,000 lbs./hr. steam and to all boilers burning fuel of over 20% volatiles.

(3) That, after a still further period, regulations (1) and (2) should apply to any existing boilers less than 25 years old. (It would not be economic to alter older boilers).

(4) Any battery of five small boilers should come under the regulations for the next largest boilers.

(5) That, after a further specified period and subject to the development of suitable devices, all existing hand fired industrial boilers, of whatever size, are equipped with suitable additions (of a design approved by the Smoke Control Inspectorate) to render them more smokeless.

The effect of these regulations would be to increase thermal efficiencies and they would therefore be economically sound ; they would at the same time make a large visible improvement to the skies of industrial Britain though they would not reduce general dirt as much as would smokeless houses. The time periods fixed should not be too short for the manufacturers of equipment and for the further development of subsidiary smoke prevention devices ; then those manufacturers who make only hand firing equipment without adequate smokeless devices will deserve to lose business for not keeping abreast of modern developments. Equipment must, as already said, be suitable for the classes of

coal available—during the war years Fuel Supply Officers have been known to allocate competely unsuitable coals even to stoker fired installations (e.g. fine coals to sprinkler grates designed for washed singles) and smoke and grit emission have been inevitable to the annoyance of the inhabitants and to the unnecessary worry of the factory management who had no control over the matter.

As regards the suitable device mentioned in (1), during the war the Fuel Research Station developed a modified firing door with automatic secondary air inlet for the prevention of black smoke from the boilers of coal fired ships. This has been claimed to be a great success and to be equally applicable to land boilers such as hand-fired Lancashire boilers It is regrettable that the Government did not publicize the device immediately the war ended in August 1945[14] and have it fitted as an example on at least one boiler in every large industrial town. Publicity by means of working examples is worth far more than paper propaganda, which in any case often fails to reach the people for whom it is written.

The small colliery boiler plant is usually responsible for an almost continuous banner of nearly black smoke. Often little is done about it because the colliery is in relatively open country and its smoke may in fact do most of its damage in the area of a different Local Authority. The excuse of the colliery is usually that it burns poor quality coal, such as middlings or washery slurry. Means for reasonably smokeless combustion of these classes of dirty and wet coal are fast improving, e.g. use of pulverized fuel firing (which is adaptable to all classes of dry coal) preceded by coal driers, if necessary, and followed by adequate dust catchers as discussed previously. Washery slurry would remain a difficult problem and sympathetic consideration and relaxation by Smoke Control Officers might be given for a time to plants which are burning this fuel, but the argument that smokeless combustion of any unsaleable colliery coal requires more expensive equipment must not be allowed to carry any weight as the fuel is correspondingly cheaper.

We may conclude this section by remarking that many new factories installed by or on Government account during the war, including all the Ordnance Factories (where entry of grit or soot into explosives could have dangerous results), were equipped with boilers, many of them small, which were so smokeless in operation that it was difficult to see from a few hundred yards distance whether the chimneys were discharging any flue gas. There can, therefore, be no arguments that small boilers cannot be made smokeless by installation of appropriate automatic stokers.

(*iii*) *Railways.*

The Railway Companies are already well aware[15] of the smoke nuisance from large marshalling yards and big engine sheds where numerous locomotives raise steam. The latter nuisance can be reduced by training of firemen coupled with suitable disciplinary measures for persistent offenders—difficult to enforce in these days of labour shortage, and at night.

The marshalling yard nuisance will probably soon be solved by the diesel or diesel-electric locomotive, which is in any case more economic

Regional Smoke Control Officers would undoubtedly be able to bring more effective pressure to bear on offending railway yards than can be done at present by Local Authority officials.

(iv) Oil-Burning Equipment.

A badly run oil fired boiler can produce a fouler sticky smoke particle than any coal fired boiler and yet the means for burning oil smokelessly are perfectly well known. Usually the smoke is produced for long periods because the boiler operator cannot see his chimney, often the installation is relatively small and is in the heart of a city, such as in an hotel.

The installation of smoke density recorders and alarms should be made compulsory. Thereafter heavy penalties for this nuisance should be rigorously enforced. In normal times those who can afford to burn oil can afford to take the necessary measures to prevent smoke from its combustion ; in the immediate future, large scale industry is being faced with having to install oil burning equipment owing to the shortage of coal. It is necessary that the Government should let it be known at once that slovenly installations which produce oily and sooty smoke will not be permitted to operate. It should be useless for the technically incompetent managements to say that they cannot help making a little smoke—the experience with thousands of oil burning installations in the U.S.A. proves that it can be helped as does the experience of the Navy and Merchant Navy.

(v) Gas Works and Coke Ovens.

Little need be said here since plants in good repair are relatively smokeless though old coke ovens are aften smoky due to leaky oven walls and oven doors. The Smoke Control Officers proposed would have just that engineering knowledge necessary to make sure that managements were really maintaining their plants in as good condition as possible.

As regards new plants, a recent improvement is the provision in modern coke oven batteries of two draw-off mains, which has the effect of reducing the smoke evolved when the ovens are charged with fresh coal. Smoke Control Officers should be able to report on all experimental work leading to improvements such as this and thereafter the installation of well tried arrangements could be made mandatory.

(vi) Iron and Steel Works including Engineering Works.

The main problem is that of the small works. Certain operations requiring a reducing atmosphere will always remain really dirty as long as they are performed with coal. The plant fired with hot coal producer gas made from high volatile coals will also give out very dirty smoke when the flues are cleaned by burning out the tar. The problem will remain until better methods of gasification of coal for this purpose are developed. In large works improvements have been made but in small works progress has been far too slow during the past twenty years and more intensive research on the subject is obviously required on the part of the manufacturers of steel furnace stokers and producers—otherwise they will find their business will go through the changeover to coke oven grid gas or to entirely new methods of gas production. A review of the problems is given in Reference 16.

The contribution of these industries to the total atmospheric impurity in the country is, except in a few districts, relatively small. Consequently it is better to leave the cleaning up of the industry to a date when more readily practicable means of abating its smoke nuisance have been evolved. Smoke Control Officers should be empowered to press for better methods, however, as they are fully developed.

A few blast furnace plants do, however, merit attention, namely those which burn or discharge blast furnace gas without removing the dust efficiently. Since the means of cleansing are known and the tonnage of dust is high, there is no reason why these plants should not be made to conform to the rules already suggested for the dust discharge from Power Stations and other large boiler plants and come under the jurisdiction of the Smoke Control Inspectorate.

(vii) Clay Industries, in particular the Potteries.

It would appear that, with the present state of technical development, some heavy smoke is bound to be discharged when firing many classes of clay, and it is useless to propose regulations forbiding the emission of smoke. The reasons for this perhaps pessimistic attitude lie partly in the fundamental chemistry and physics of the process. During the first period of firing, "the water smoking period," moisture must be evaporated off very slowly for many days to avoid cracking of the ware and the temperature in the kiln must be kept below 200-250°C. Even after this stage is completed, the temperature may still only be raised slowly to 600°C. during which time the chemically combined water is removed from the clay and some changes occur in the crystalline state of the constituents of some goods, especially silica goods. Thereafter, in the "Vitrification Stage" the temperature is raised more rapidly and up to 1,100°C. or even 1,400°C. for certain goods. But in this last stage, oxidising and hence smokeless conditions are not always permissible, and a strongly reducing atmosphere is required, e.g. in the finishing of blue bricks.

The intermittent kiln is a far greater smoke offender than the continuous kiln, and, in fact, the large tunnel kiln in which the goods pass through the kiln in trucks can be made practically smokeless in operation. Unfortunately this type of kiln is not suitable for a great many manufactures. Again, intermittent kilns can be fired smokelessly by producer gas or by coke in some of the stages of the operation, but the changeover to final firing by coal would not be a very practicable operation. It must always be remembered that, like the steel industry, this is a highly technical industry where the quality of the finished article is of the utmost importance and where conditions of firing for one product may be entirely different from those of another—fired in the same kiln. We shall also have to accept the fact that the Pottery Industry is situated in a soft coalfield where the coal has a high volatile content—a quality which is stated to be necessary for certain operations. An excellent summary of the problems is given in Reference 17.

Although the industry realizes the smoke nuisance it creates, it is doubtful if sufficient effort and money are being spent on large scale research and development of new types of kiln and grates for smokeless firing.

(viii) Cement Industry.

The Cement Industry was for many years the subject of complaint on account of dust nuisance from its chimneys. The dust discharge is somewhat similar to that from powdered fuel fired boilers. In 1906, the industry was placed under the Alkali Works, etc. Regulation Act and its smoke and dust problems therefore come under the Alkali Inspectorate. There is no need to say more than that the most modern dedusting plants installed by this industry have a high standard of efficiency and that there is evidence that the Chief Alkali Inspector and the Industry are always on the look-out for improved and cheaper apparatus to install on new or modernized plants.

(ix) Lime-Burning Kilns.

As in the Pottery Industry, it is essential to appreciate :—

(1) That the physical chemistry is extremely complicated. Lime is an essential in a great variety of the basic industries where the processes call for many grades, all of high chemical purity but having different physical characteristics.

(2) That the quality of the resultant product is, inter alia, a function of kiln temperatures, " burning " time, and quality of fuel.

Temperatures which are higher than the optimum are undesirable because, apart from the narrow margin between existing lime kiln temperatures and the critical temperature of existing refractories, such temperatures produce lime of a quality which is unsuitable for many markets, and, moreover, accentuates those differences in degree of burning associated with variation in the size of stone fed to the kiln.

(3) That the chemical change in a lime kiln takes place in an atmosphere containing a high percentage of carbon dioxide resulting from the disassociation of the limestone.

It will be clear, therefore, that the problem of smoke emission in lime burning is not merely a question of producing the most efficient combustion regardless of furnace temperature.

Material reductions in fuel consumption have been made in recent years in some of the more modern installations, and further advances in technique should undoubtedly result from present and future research work and the incorporation of the results in new plant. Nevertheless, even when a process have been evolved which satisfies all the exacting requirements as regards quality and dependability and simplicity of operation, there still remains the major question of extensive modification to, or replacement of, plant on existing sites.

(x) Future Research and Development.

As will be seen in the preceding sections, there are some industries where a substantial reduction in atmospheric pollution could be obtained by installation of equipment to give not more than a maximum specified discharge of smoke and dust measured in a prescribed manner[18]. But there are other industries where smokeless methods of operation using coal have not been devised and where alternative fuels either do not give the required quality of product or are grossly uneconomic.

Research on reduction of smoke from such processes is steadliy proceeding all over the world but there is the weakness that the full scale development and testing of the ideas arising from research lag far behind. The reason is that this type of development is not only far more expensive than small scale research but that it cannot be done in the premises of Research Associations or in most industrial research laboratories. A remedy might be found if the Government would co-opt small but strong working committees from the industries concerned with the responsibility of designing and building prototype full scale smokeless furnaces in works selected by the industry. The capital cost of these furnaces should be a charge on development, an agreed rent being paid by the firm on whose premises the furnace is built based on the capital cost of the alternative current design and rent being paid only when the furnace is producing material to correct specification and at design output. This type of development research might take ten years and would be expensive; it is suggested that the money required for the ten years should be obtained in equal proportions from the Government and from the industry (e.g. by a levy in proportion to the quantity of soft coal used in non-approved equipment).

These committees should tackle the problems in the order of greatest volume of black smoke, and they should aim, as a first step, at reducing black to light brown smoke rather than colourless. From the results obtained, the Smoke Control Inspectorate and the industry in question should be able to draw up a list of approved equipment exempt from the levy and possibly a black list which should not be installed in any new works or extensions. In time, therefore, the atmosphere of these industrial districts will be improved. As it is to be expected that the smokeless equipment would give a higher overall thermal efficiency, there will also arise an economic incentive to replace old units by units less smoky in operation.

Discussions and Conclusions.

It will be observed in the foregoing sections (a) to (f) that an endeavour has been made to outline a set of regulations to which industrial engineers could operate without much extra expense. The proposals made are those of an industrialist and not of a lawyer; no claim is made that they are water-tight nor all-embracing but it is believed that regulations phrased on these lines are easier to operate and easier to amend to give better results as technical discoveries and improvements come forward.

The author has not only rejected the proposals of the National Smoke Abatement Society to strengthen the hands of the Local Authorities through the medium of new byelaws: he has also suggested in effect that part of the Public Health Act should be re-written and then administered for the Ministry of Health by the Ministry of Fuel and Power on whose staff expert combustion engineers and other suitable technicians are already to be found. The weakness of the 1936 and previous Acts[18] is that there is no definition of "black smoke," no definition of the qualifications of an officer of a Local Authority authorised to decide when smoke is a nuisance and no body of technicians to tell offenders that there are better constructions of furnaces to consume

smoke or better types of dust arrestors which constitute "best practicable means." It is not suggested that these matters should never be brought for decision to the Courts but it is felt that much injustice is done to the inhabitants in some areas because of absence of precise standards. There is also no intention to imply that the Ministry of Health should not concern itself any more with smoke nuisances—it should be at liberty to ask for remedial action by the Ministry of Fuel and its Officers.

No mention has been made of the millions of householders engaged in stoking their little fires; yet according to the Leicester Survey[6] half the smoke in Great Britain is estimated to be of domestic origin. It is to be hoped that Simon's Report on "Domestic Fuel Policy"[19] will be implemented by the Ministry of Fuel and Power: this Report makes suggestions for the prohibition of manufacture and sale of appliances falling below approved standards and in this and other ways recommends somewhat similar proposals to those laid before you in this paper.

In conclusion the author would like to pay a tribute to the National Smoke Abatement Society which has now seen 47 years of honourable and successful service. It has played an important part in educating the public and has done valuable propaganda work. In this role it will continue to have the good-will and friendly support of Industry and it will be to their mutual advantage to study together how their common aims can best be achieved.

REFERENCES AND NOTES

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9. F. Favell, "Considerations Concerning the Siting of Power Stations," J.Inst.El.Engrs. 1942, Part II, p.221.

10. H. L. Hohenleiten and E. F. Wolf, "Novel Tests for Stack Height," Combustion, Jan. 1942, p.38.

11. Compare evidence given at enquiry by Ministry of Works and Electricity Commissioners into the proposal to erect a Power Station at Kepier near Durham, where the plant was to give an exit of 0.1 grs./ft.^{3} at 132°C. or 0.14 grs./ft.^{3} at 0°C.

See also description of extensions to Hams Hall Power Station (Birmingham Corporation), Engineering Vol. 145, p.212 (1938), where the specified exit dust concentration from new electrostatic precipitators was 0.10 grs./ft.^{3} at 155°C. or 0.16 grs./ft.^{3} at N.T.P.

12. Coal Survey Paper No. 58 (H.M.S.O. 1946) classifies coals as low volatile (less than 20%), medium volaitle (20-30%), and high volatile (over 30% volatiles). The information on the suitability of any coal under such a regulation is therefore readily available.

13. Manual of Ordinances and Requirements in the Interest of Smoke Elimination and fuel Combustion—papers read to 34th Annual Convention of the Smoke Prevention Association of U.S.A.; Chicago 1940.

14. Mention of the device was apparently first made in the Institute of Fuel for February 1946, p.111—Eng. Vice-Admiral J. Kingcome "Fuel Problems in War Time in the Royal Navy," but no description was given.

15. M. G. Bennett "Railway Smoke," Institute of Fuel 1945.

16. H. C. Armstrong "Modern Methods of Dealing with Smoke Prevention Problem in the Iron and Steel Industry"—Proceedings of National Smoke Abatement Conference, October, 1936.

17. E. Rowden and A. T. Green "The Problems of Smoke Emission in the Heavy Clay Industry"—Proc. of National Smoke Abatement Conference, October 1936.

E. Rowden, W. Noble and A. T. Green "Smoke Abatement in the Clay Industries," Inst. of Fuel 1945.

18. See summaries of these acts in "The Law of Smoke Nuisances" by W. R. Hornby Steer, published by National Smoke Abatement Society, 1938.

19. Domestic Fuel Policy—Report by Fuel and Power Advisory Council; H.M.S.O. 1946.

DISCUSSION

H. G. Clinch (West Ham) said that he was pleased that the economical aspect of smoke abatement had been so strongly stressed in the papers. It had been his experience that usually the boiler house involved more expenditure than anywhere else in the factory, yet even to-day it was the one place where no balance sheet was called for, at any rate, so far as the smaller installations were concerned. When results were required they were usually on the wrong basis. The owners merely wanted to know the evaporation of how many pounds of water per pound of coal, whereas, of course, they should ask how many pounds of water per pound of money expenditure—which was a different matter altogether and was the true test of efficient working. He wished to correct his friend, Mr. Humphrey, when he implied that friendly co-operation with industry and the reliance of industry for friendly advice, and the safeguarding of trade secrets could only be achieved by an officer appointed by a Government Department. Mr. Clinch said that this was nonsense. He had, in his experience, achieved just that state of affairs when he was engaged in the West Riding of Yorkshire, and owing to the economies in working achieved, industrialists were very pleased indeed to see him at their works. He challenged Mr. Humphrey to quote a single case in the whole of the history of Local Government in this country where trade secrets had been divulged by a Local Government Officer. He said such a thing was never discussed because it was unheard of. Mr. Clinch emphasized that the Ministry of Fuel had their proper place in the scheme of things. They could collate information from the Research Departments of all the various industries, but having done so, should then be approachable by the officers of local authorities, and stop this "taboo" whereby officers must not communicate with a Government Department except by resolution of his Authority and through the Town Clerk. He said that quite frankly he had studied combustion and the working of steam boilers all his life and did not know the subject and he would not boast as an authority on all branches of combustion engineering, nor, if he had any sense at all would the man at the Ministry of Fuel. Nevertheless, a team of men could between them be able to assist.

Dr. R. Lessing (Member) said that Mr. Humphrey with his usual thoroughness had given a correct and succinct account of the industrial smoke problem. Mr. Humphrey would forgive him if he could not agree with his plea for a National Smoke Inspectorate. He yielded to none in his admiration of the work done by the Alkali Inspector's Department. It might well serve as a model of beneficent Government control, but here the analogy ended, for it dealt with a limited section of industry and, being staffed by a few dozen experts, could be controlled with an efficiency which could not possibly be achieved with a staff running into hundreds or even thousands. By all means let common standards be worked out, but keep local control on what was a local nuisance. Regarding standards, he felt compelled to defend B.S.893. It might appear complicated, but dealing with a complex problem, this could not be avoided. The Committee responsible for its production had resumed its work, and was actively engaged on its revision in the light of the experience gained, and of present and future requirements. Dr. Lessing's main point in dealing with Mr. Humphrey's paper was to reiterate his conviction that the smoke problem could only be solved by tackling it at the source. In his paper read at the Bristol Conference, 1935, he had traced the sources of atmospheric pollution. Smoke of the old type, consisting of tarry smuts, formed a negligible part of the present-day emission from factory chimneys. The visible matter in it consisted of ash dust and small coke particles, the bulk of which was derived from fine dust in coal. This was lifted from the fire-bed and carried to the flues and chimney, coked but largely uncombusted. of the 10 million tons of this dust (passing a 60 B.S. mesh screen) contained in the annual coal production, something of the order of one million tons appeared as visible chimney emission. Take out this dust at the colliery, use it in pulverized fuel furnaces, and the major problem which confronted them to-day was solved.

The Society should attack the problem at that end, and press for the elimination from the coal supplied, of the root cause of the evil. He was sure Mr. Humphrey, an old coal cleaning colleague of his, would agree with this proposition, in preference to "passing the buck" to a neighbouring area by building high chimneys or creating smokeless zones. Pending the time needed to put this proposal for prevention into effect, it would be for the authorities to insist on the best practicable means of a curative nature to be used, by way of the installation of grit arresting plant and competent boiler management, to eliminate the offending matter which should never have reached the firegrate. That this could be done with 100 per cent. efficiency was shown by the examples of Fulham and Battersea power stations. Moreover, these plants accomplished the solution of sulphur acids. Whilst smoke, grit and dust must be definitely regarded as an abominable nuisance, the sulphur acids, though invisible, were the insidious enemy which caused the real damage usually ascribed to smoke.

James Law (Sheffield, Rotherham and District Commitee) said he was supporting the proposals for new industrial legislation. In 1945, an Installations Sub-Committee of the Society's Council was formed and the result of their deliberations was the draft regulations they were now considering. Mr. Duguid's paper was a concise masterly effort, summing up what has been aimed at—correct design, adequate maintenance, and proper manipulation. He stated that the proposals were far-reaching and drastic, but they were practical and there was nothing contained in them that went beyond the bounds of technical possibility.

Mr. Farquharson had some doubt with regard to the provisions coming within the purview of Section No. 104 of the Public Health Act. If the emission of smoke from new buildings was to be controlled, the only way of doing it was in the manner specified—design, maintenance, and manipulation. Mr. Farquharson then openly disagreed with the licensing of furnacemen and firemen to operate these registered installations, yet he must know as well as all Inspectors that the best designed and maintained combustion plant in the world could be as bad as any other if handled with lack of care, or lack of understanding. Mr. Farquharson thought that the suspending of a licence was going to prove a hardship, yet as a certified engineer who had control of hundreds of firemen, he must appreciate that from a point of view of sobriety alone, apart from working ability, that method of registration would eliminate certain undesirables. His point regarding the lack of provision for "trainees" was one that may need a "time factor" adding. The licensing of men could be made to operate twelve months after the operation of the byelaws, to enable men to take their training and certificates. As an alternative licences could be granted to all men making application, who could show that they had had some experience with the plant being operated. The licence was operative for three years and that should be a good probationary period.

Mr. Bowles's only objection appeared to be that the stoker's job should be graded with an attractive rate of pay. Did he not realize that this was the "Fireman's Charter," and gave the men an opportunity they have never had before of demanding better rates of pay and better conditions? It would definitely grade firemen and furnacemen as "craftsmen." And lastly, he wanted to say something about the industrialist's point of view. It was one of the most remarkable papers he had had the privilege of reading, but as a practicable workable solution to smoke nuisance, it showed a lack of understanding of existing conditions in industrial areas, that was almost unbelievable. Mr. Humphrey stated that "industry has been the chief contributor to the solution of the smoke abatement problem," he would reply by stating that industry always had been and still was the principle contributor to atmospheric pollution, which was not caused by a small and backward minority but by some of the largest consumers of fuel in the country. He would quote electricity undertakings and the concentrated emissions of dust and sulphur that were continuous. If smoke abatement methods could show added efficiency the industrialist was interested, but if there was no return for the expenditure, little interest was shown. Mr. Humphrey stated that the Public Health Act had neither defined "black smoke" or the "best practicable means" and that no Smoke Inspector could work efficiently with such ambiguous phraseology, nor could the designer of new plant. He had been

a combustion engineer and a Smoke Inspector for 36 years, and though he admitted that the Public Health Act was not all that was desirable—the men who made the Act had been dead many years, he suspected—if it was used with tact and common sense, and people would co-operate, there was no difficulty to overcome. Mr. Humphrey then asked that photo-electric cells should be fitted to all chimneys. In the area which he controlled there were about 3.900 chimneys serving 850 boiler houses and about 4,500 metallurgical furnaces. Half the boilers were not even housed, very few of them had any means of measuring the amount of water evaporated or the fuel used, and flue gas recording was non-existent. Metallurgical process chimneys in many places were about the same, so there was plenty of more essential recording necessary before they came to precision smoke measurement. Certain firms in the area fitted photo-electric cells prior to the war but owing to lack of servicing they had fallen into disrepair and disuse. He was in entire agreement with Mr. Humphrey regarding the appointment of Smoke Control Officers, but why should they be attached to the Ministry of Fuel and Power? They should be employed by local authorities who were dealing with future planning and development and who had a better knowledge of local needs and requirements. Without wishing to be personal in any way, Officers working as Regional Engineers appeared to have spent most of their efforts in coercing people to use low grade fuels, irrespective of the type of furnace or boiler in use or the demands made upon it. There had been a serious lack of discrimination over this problem, efficiency, suitability and smoke emission being completely ignored. He was amazed that Mr. Humphrey thought that "smokeless zones" were no real solution to the problem, for if such areas were not agreed upon in the industrial areas, **where did smoke abatement commence?** Why should industry be opposed to the Prior Approval of heating plant? If the type selected was good, and there were many proved methods that were of advantage, they could be passed on to the person installing new plant. One of the difficulties in the past had been the lack of uniformity and the lack of interchange of ideas and methods. In the larger cities a system of prior approval had been in operation for some time with mutual advantage to all concerned. The height of chimneys had always been a vexed question and would remain so. Large power stations very often were the worst offenders—a journey from London to the North would soon convince anyone of that—where the chimneys of almost every electricity station were barely higher than the top of the building and certainly not 50 per cent. higher. Dealing with gas works and coke ovens, Mr. Humphrey stated that these were "relatively smokeless." Anyone who had lived in close proximity to a coke oven plant would take strong exception to that statement. They had eleven coke oven plants in their area and it was safe to state that they caused more atmospheric pollution than any other heating plant; "green gas" from the recharging and sulphur and dust-laden vapour from the quenching towers was almost continuous. The Alkali Inspectors would not take any action about these principle causes of nuisance. He was afraid Mr. Humphrey was sadly out of date about steelworks' practice. About fifty million cubic feet per day of gas was used, which represented probably about 15 per cent. of the total fuel demand. They hadn't any more gas nor are they likely to get any and other fuels would have to be substituted for the purpose. Provided that suitable appliances were installed metallurgical furnaces could all control their smoke emission, irrespective of the type of fuel used, though gaseous fuel was preferable for heat treatment and low temperature working. Now was the time for cleaning up when many of the furnaces in the area were about to be renewed after their war-work. Some of the larger works had shown remarkable results in this matter, but there was still an amount to be done. He would refer Mr. Humphrey to a paper given by Dr. Fells at Doncaster last April for the Society and the Institute of Fuel.

Mr. Humphrey, concluding, stated that he had rejected the proposals of the National Smoke Abatement Society and substituted his own, very politely suggesting that Local Authorities should hand over their duties to the Ministry of Fuel and Power for further working. Did Mr. Humphrey know that the sub-committee that framed these byelaws were competent engineers with years of boiler-house

practice and practical experience behind them? Did he also know that in their large industrial cities, smoke abatement work was carried out by qualified engineers — Birmingham, Liverpool, Glasgow, Sheffield and Leeds? The Public Health Act, 1936, gave local authorities powers to make byelaws respecting new buildings: they wanted those byelaws now whilst reconstruction was going forward, not years hence as Mr. Humphrey suggested, when they had "missed the boat." At the moment the Ministry of Fuel and Power had enough troubles of their own to overcome without usurping other people's work about which they had little or no knowledge.

Dr. A. C. Monkhouse (Fuel Research D.S.I.R.) said that Mr. Humphrey had referred in his paper to the modified firing door developed at the Fuel Research Station for the elimination of smoke from the boilers of coal-fired ships This device was developed during the war and fitted to over a thousand ships. Its object was to prevent ships in convoy giving away their position by the smoke trail from their funnels. Considerable instruction was given in the operation of the smoke eliminators by means of films, lectures and demonstrations to stokers. It had been shown at the Fuel Research Station that when smoke emission was reduced, there was a decrease in fuel consumption. The saving in fuel could be as much as 10 per cent. in extreme cases, where black smoke was emitted. Recently members of the Fuel Research staff had carried out boiler tests at sea under ocean-going conditions, and had shown by the use of smoke eliminators a saving in fuel of 5 per cent. The report of this trial was in the hands of the printers, and would be obtainable through H.M. Stationery Office. The loss of heat when smoke was emitted was due mainly to the invisible combustible gases — carbon monoxide, hydrogen, and methane. The loss due to these gases was three times the loss due to the visible smoke. The same principle as used in the marine boilers had been applied to a hand-fired Lancashire boiler, at the Fuel Research Station. Many demonstrations had been given, and the system was now being tried out in boilers in industrial use. A paper describing the system would appear in the next issue of the "Fuel Economy Review."

Councillor Mrs. A. E. Prendergast (Dagenham) spoke on the subject not only as Chairman of the Health Services Committee of the Dagenham Borough Council, but as the wife of a stoker. There was no doubt that the need for considerable improvement in the working conditions and wages of these men was urgent and long overdue. Their work was skilled and should be paid for as such; they would then attract the right type of man to the job. Training was essential—but was this to be done in the man's own time? Surely the only reasonable method in these days was for the employer to grant facilities for training during working hours. As for the licensing of stokers, she was confident the men themselves would very strongly oppose such a measure and would support their objection. That method would certainly restrict the liberty of the individual and tend to the regimentation of a certain section of workers. Register the plant by all means and thus ensure that the installation was suitable in all respects, and ensure that the human element was suitable by proper training, improved working conditions and rates of pay.

Councillor E. A. Smewin, J.P. (Oxford) said that he did not think that our proposals would go far enough as he wanted something done to deal with the present nuisance of industrial chimneys He stated that when they called in an expert regarding the nuisance from their Municipal Electricity Works, which was situated in the midst of a densely populated area, they were told that a chimney 350 feet high was needed but that the Electricity Commissioners would not allow it to be built. Since last April they had been sent by the Ministry of Fuel and Power 29 different grades of coal, including several lots of outcrop coals, and that as a result the stokers did not know how to fire the furnaces to prevent the emission of smoke.

Councillor J. Duffus (Bexley) commented upon the name of the Society, suggesting "Anti-Atmospheric Pollution Society" because there were many atmospheric problems which could be tackled which, at the moment were not covered by their present name and constitution. He then quoted the need for new industrial legislation to prevent cement kiln grit, plaster board

dust and asbestos dust being disseminated over industrial and other areas.

G. W. Farquharson, replying to the discussion, said that as most criticism appeared to be directed towards his statement concerning the licensing of the person who fire or operated the boiler or furnace, registered under paragraph 11 of the New Proposals, he again said that he was convinced that such a form of licensing would not be helpful to the cause of smoke abatement. One could not draw the same analogy between a registered plumber or a certified engineer or doctor. As he read these proposals, and one must include paragraphs 11, 12 and 13, the fireman or furnace man could only be licensed for the type on which he had experience ; therefore it restricted his mode of livelihood. For example, how could one licence a furnace man on a brick kiln to include hand firing on a water tube boiler ? Finally, although examples, such as licensing of slaughtermen and milk premises, etc., had been quoted, he believed it could only be accomplished by an Act of Parliament and not by any byelaws.

Mr. H. A. Humphrey, replying to the discussion, regretted that there had been no technical discussion of his paper. No facts, figures or arguments contained in the paper had been challenged and therefore no technical reply was required. A good many speakers contended that the administration of any future legislation on smoke abatement should be administered by local authorities. This was natural since all local authorities throughout the country were invited to be represented at the Conference, but no speaker developed any logical argument to support this view. Dr. Lessing was in favour of administration by local authorities but he held the view that it was proper for such authorities to call upon independent consulting engineers to advise them on the matters concerned, so that local smoke inspectors were relieved of their responsibility for technical decisions. The author believed that this view would not be upheld by many local authorities nor did he think it would tend to uniformity of technical standards even for the same industries in adjacent areas. The author hoped by his paper to provoke a discussion on the technical and practical proposals he had presented. Instead there was a simple disagreement with his conclusion that the only practical and efficient scheme must be based on legislation which provided standards, tests, and approval of appliances at a high level, and administered centrally under the Ministry of Fuel and Power. A simple denial of this did not carry the matter any further so that the only result of the Conference was to establish the fact that there was a decided difference of opinion. The merits of the different proposals had therefore still to be elucidated.

THIRD SESSION

Saturday Morning, 26th October, at 9.30 a.m.

Chairman: **Alderman J. Talbot Nanson**
(Chairman, Publicity Committee, Brighton)

WHAT OF THE FUTURE?

By CHARLES GANDY.

War on smoke has to-day reached a stage which may be compared with that in the recent war just before the opening of the Second Front. "I doubt," said Mr. Clough Williams-Ellis at our 1943 Conference, "whether there is any reform so generally recognized as necessary and that would yield such immense and immediate improvement in return for a short, sharp and determined Blitz, as that against our centuries-old oppressor, Smoke." Till very recently such a Blitz was almost inconceivable. The Central Government seemed content with a "phoney" war. Local Health Authorities, keenest for the attack, fought with one hand tied, their only weapons those from the Public Health Act, 1875, powerless against the massed output of smoke from tens of thousands of offices and commercial buildings and over 12 million homes. Such smoke has even in recent years, enormously extended the territory it holds in unchallenged occupation. We are about to open our attack on this occupied territory. Let us therefore examine the positions we have so far reached, and from which our further campaign must move forward.

Where We Stand.

In the first place, there is now no city or town of consequence in the the country whose Health Authorities do not regard the elimination of smoke as essential to public health. The responsible words of Dr. Veitch Clark (late M.O.H. Manchester), "The abolition of smoke from our midst would do as much for the improvement of public an individual health in our industrial centres as any other single action open to this country"—and of Dr. Johnstone Jervis (M.O.H. Leeds), "In permitting the pollution of the air we are doing a disservice to our own generation, and inflicting a handicap on future generations," are echoed with ever-increasing emphasis by every Medical Officer of Health throughout the land. At this Conference in Brighton, Medical Officers, Chairmen and members of Health Committees, health inspectors from all our great centres of population, have united in their hundreds to demand that the fight should move forward. Behind them are the millions of ordinary citizens who have learnt to believe that victory is in sight, and that the dirt and drudgery associated with life in cities will soon be a memory of the past. More and more the newspapers of the country are giving voice to this same hope—and in the many important journals concerned with municipal and technical progress increasing space is found for a matter freely recognised as of topical and essential importance. The country is ready for the great attack to begin in earnest. Where then

are the preparations for it? Where the central organization and driving force which should be behind it all? At present, it is not as one might have hoped the Government, but the National Smoke Abatement Society alone which is the connecting centre for this nation-wide resolve to have done with a nation-wide evil. The Society's powers are limiited—it can help to instruct and educate public opinion—it can encourage action by its local authority members under their existing powers, and advance suggestions for enlarging those powers. It is the Authorities themselves who are the front line of the battle. Parliament alone can provide the new powers they need and the responsibility for the direction of operations lies and must increasingly lie with the Central Government.

Challenge and Opportunity.

The reasons which, apart from the educational work which has been carried on, have made the present time of challenge and opportunity are well known, ,and may be summarised :—

(1) It has become apparent that an optimum use of our fuel resources is essential in the public interest, and the whole fuel industry is coming under public control for that purpose.

(2) Technical advances in respect both of fuel burning installations and appliances and of the production of smokeless fuels are such that a rapid change to smokeless methods in factory and home has become generally possible with advantages for all concerned, in efficiency, economy and comfort.

(3) Millions of our younger people returning from war service to homes and places of work darkened and degraded by smoke demand, rightly, something better.

(4) There are thousands of acres of war damaged areas in which it should be criminal to erect any but smokeless buildings.

(5) Most larger local authorities have prepared or are preparing plans for the whole of their areas. Such planning is impossible without taking into account the extent to which the concentration and drift of smoke will be overcome. In fact, most of the plans anticipate complete or almost complete smokelessness.

(6) It is generally realized that the unplanned drift into the countryside of those who can afford homes away from the smoke of cities must be stopped.

(7) Methods, for which this Society is largely responsible, have been devised for the progressive removal of the causes of smoke and the clearing away of its effects.

The Obstacles.

The causes which, in spite of the urgency above indicated, hold up the advance, are also well-known, and mainly the result of antiquated legal and administrative machinery and inadequate staff work, particularly at the centre :—

(1) There is no "second front"—i.e. against smoke of commercial or domestic sources. The work is carried on by local health departments even on the old industrial front with inadequate powers, and

either little encouragement or sometimes active discouragement from the Ministry of Health, which should be the operational Headquarters of the campaign.

(2) The enemy is allowed to become well entrenched, i.e. by the instalation of unsuitable appliances, before the authority can move.

(3) No effective co-ordination of smoke control operations.

(4) No effective fuel policy.

(5) No sufficient training of essential personnel.

(6) No "Ministry of Supply" to ensure rapid production and delivery of up-to-date appliances.

(7) No information service to rouse and maintain public interest and effort.

The Remedies.

The remedies for these faults have been devised and only wait the necessary legislation and Government action :—

(1) *Smokeless Zones.* Extension of the powers of local authorities enabling them to set up smokeless zones as bridgeheads in the "second front" assault—that against non-industrial smoke emission. The smokeless zone clause of the Manchester Act 1946, a Manchester "Mulberry" for this second front, has been launched and towed into position. It is now up to the Government to extend similar legislation to all authorities. If we really mean action on both fronts, domestic as well as industrial, the creation of smokeless zones is not merely the best method—it is the **only** method. It would be impossible to frame any legislation immediately and universally applicable to control the smoke which now pours from countless chimney stacks, from offices and commercial premises, hotels, even from publicly owned municipal buildings, as well as from domestic premises spread over hundreds of square miles. No police force or inspectorate could deal with such a problem. The only plan is to take it piecemeal—progressively—clearing the ground as we go—getting one area after another free of the nuisance, until the whole process can be speeded up when productive capacity and adequate distribution of fuel and appliances are ready to meet up-to-date requirements in all areas.

(2) *Prior Approval.* Legislation is also needed to give local and regional authorities power to secure that all fuel burning installations shall be subject to prior approval. I will not enlarge on this subject which the Conference has already discussed.

(3) *National and Regional Smoke Control.* The Government must give a definite lead in regard to the setting up everywhere of regional smoke authorities with statutory powers and duties. Without superseding similar functions exercisable by the larger local authorities, these might include the employment of an adequate staff of expert fuel consultants and inspectors, arrangements for prior approval of installations including standard domestic appliances, the taking of observations throughout the region and relating the same to those in adjoining regions, the collection and dissemination of air pollution statistics, progress reports,

and information, for the guidance of the Central Government and of constituent authorities, for the use of special classes of fuel users, and for the general public, and arranging for the training of smoke control personnel and the training and certification of stokers. Such regional committees should have their own offices and permanent officials but should be democratically controlled by representatives from the constituent authorities and work in co-operation with their health and smoke control departments. The whole country should be covered by such regional control, each of the several main concentrations of industry and population in various parts of the country being so far as possible included in a separate region.

(4) *National and Regional Fuel Control.* There must be what Dr. Lessing has called the "rational preparation" of coal for the various uses to which it is to be put. At present only about one half the coal used is washed. There must be a system of distribution organized in its broader lines nationally, but regionally and locally flexible, and ultimately in the hands of those in close touch with actual requirements. In particular the marketing of solid smokeless fuel for domestic use needs careful attention. And this regionally based and locally administered fuel organisation must be brought to work in co-ordination with the regionally based smoke control organization.

(5) *Training of Personnel.* This falls into two parts:—

(a) The proper regional organization of smoke control under statutory boards will demand the service of many highly trained consultants, inspectors and others with expert knowledge both of fuels and appliances, able to suggest, recommend and approve the best available installation for any particular purpose, and indicate the fuel available and best suited for the installation when working. Expert supervision is required not only to prevent unsuitable installations but to ensure that the best use is made of existing plant. It is instructive to refer to a survey recently carried out in New York. Of 2,200 small power plants surveyed, only 8 were found in first class operating condition, 15 per cent. had minor defects but were well operated, while two-thirds of the plants had operational difficulties, with incorrect firing heading the list. Only about 25 per cent. of combustion control and metering equipment was being operated properly. Many instruments were disconnected or couldn't be read. There was lack of co-operation between boiler-room and steam-using departments. Manufacturers would be assisted in keeping all these faults in check by the co-operation of experts from the regional and local smoke control authority working with the fuel administration.

(b) The actual training and certification of stokers and furnace men whether for hand fired or mechanically controlled installations. for fuel economy and smokeless operation it is essential that these services should be performed by skilled workers with pay corresponding to their qualifications.

Technical and scientific courses both for inspectors and operatives, with diplomas and certificates for proficiency, must be arranged in Technical Colleges or other suitable institutions and combined with practical experience.

(6) *The Mass Production of Appliances.* In spite of the pressing need for fuel economy and the urgent importance of providing tenants of all new houses with up to date fireplaces which will give pleasing results with smokeless fuel, we hear with dismay that appliances of obsolete pattern are still being produced and supplied to Housing Authorities, on the pretext that the completion of houses cannot be delayed until the new grates are ready. That this should be the case more than two years after the Housing Manual of 1944 had urgently recommended that the new types only should be used in all new housing shows an inexcusable lack of co-ordination between responsible Government Departments, and markes one wonder whether the old type of departmental official, overworked, timid, and nervously apprehensive of disturbing supposed vested interests, is not still in the ascendant. A firm declaration of Government policy in this matter coupled with the determination to allocate the required materials would have avoided the trouble and it may be hoped that it is still not too late for proper action to be taken.

(7) *A Government-sponsored Educational Campaign.* It seems strange that the Ministry of Health, which has been able to secure the expenditure of so much public money in publicity campaigns affecting other matters, continues almost speechless in a matter which Local Health Departments consider so fundamental to the health and well-being of the community. The apparatus for an extensive campaign of publicity is ready to hand in the knowledge and experience gained through many years of research and educational work by the Society, but millions of our fellow citizens are still in ignorance not only of the damage caused to themselves and others by their own unconscious contribution to the smoke nuisance, but also of the steps which they might quite simply take to avoid making such a contribution. The smoke polluted condition of the air of our cities is regarded as something natural and from which there is no escape but in getting away from them. As anyone who moved through the Manchester Art Gallery when the Manchester Plan for a completely smokeless city was being shown must have noticed, there was a surging undercurrent of enthusiasm which could easily be turned to account. If people are shown not only that smokeless cities are possible, but that with a slight change in some of our habits they are in fact now attainable the degree of public support for the necessary regulations can be enormously increased. Again it is for the Government to make a plain declaration of policy and to back it up by suitable publicity.

Signs of Repentance.

Some may think the picture I have drawn of Government indifference to a matter of such far reaching importance too black—or at least unfair to those now taking charge of the Departments most concerned. Fortunately we must admit a recent change for the better. Apart from individual pronouncements this was first noticeable in the *Housing Manual* 1944, published jointly by the Ministry of Health and Ministry of Works, which after recognizing the present " widespread demand that

the evil of atmospheric pollution shall be resolutely attacked " added that " the Government attach particular importance to smoke abatement in view of the injury to health and to general amenities caused by atmospheric pollution " and referred to the extra labour for the housewife as " another evil result which must not be overlooked." This has been followed by the Report on Domestic Fuel Policy by the Fuel and Power Advisory Council presented in March this year, by far the most important document relating to smoke abatement yet published by any Government. The Council under the Chairmanship of Sir Ernest Simon gave its weighty support to policies urged by us, recommending in particular Government action for increasing supplies of smokeless fuels and up-to-date domestic heating appliances, and the setting up of smokeless zones as a first experiment towards obtaining control of smoke emission from all sources.

Effect of Smoke on Agricultural Productivity.

There are two further aspects of the smoke evil to which I think insufficient attention has yet been given by the Government or by others most concerned. One is the effect of smoke and the smoke cloud on agricultural productivity. The growth of the smoke cloud over our coutryside has been so gradual that we easily think of it as a natural climatic condition. Besides the damaging effect of falling soot and acid extending far outside the smoke producing areas and causing an average annual deposit of not less than 10 tons per square mile in rural districts, it is now estimated that 2 out of the 3 million tons of smoke pollution emitted in solid form is in so fine a state as not to descend by gravity. Carried upwards to the lowest temperature inversion, often near the stratosphere at a height of some 33,000 feet, some 40,000 tons of this " air flotsam " is usually hovering over the whole country, cutting off a high percentage of available light, especially in those climatic conditions when maximum light is needed for plant growth. The overall loss in agricultural productivity, including that of market gardens and allotments, has been estimated at as much as between 20 per cent. and 30 per cent. It is hoped that Agricultural Research Stations will in the near future make a closer study of these effects, and that Farmers and Allotment Holders' Associations will give the matter the attention it deserves.

On Social Discontents.

The other aspect of which I speak is an aspect which one wishes could be forced on the attention of the Government. As Sir John Martin Harvey wisely put it " The lack of beauty in the lives of the people, so poignantly felt but so inarticulate, the lack of that comeliness in their surroundings which has so civilizing an effect upon the character, is ignored by Governments, and is largely the cause of social discontents." A sense of " frustration " is widespread. The average citizen does not live in the political atmosphere of Whitehall. He is not cheered, or depressed, by balance sheets or blue books. He comes home—if lucky—to a house or flat tolerable enough if it and the whole neighbourhood he

and his family must live in had not taken on the monotonous dinginess of the smoke-sodden town of which it is part. He is depressed by the semi-darkness of it—his wife tired by the endless housework of which he feels she would have so much less in a better neighbourhood. Perhaps it is much the same where he works. Soon his one idea is to get away to something better. The impulse to improve one's environment is normal—if frustrated, it is superseded by the restless impulse to get away from one's environment. The former impulse expresses itself in work, the latter in the mere desire to make money enough to buy what others cannot afford.

The individual inhabitant can do little to improve the surroundings of his home—practically nothing about the atmosphere in which it is buried. If "they," i.e. the Government and responsible authorities, do nothing, is it surprising that he joins in the demand for a better wage ?—if only that he and his family may get away, like everyone else who can afford it, into happier surroundings and a fuller life. No amenities are more economical to purchase—more worth while—than those purchased for the common enjoyment of a whole community—but the most fundamental amenity, which should cost nothing, is freedom to enjoy fresh air, clear daylight and clean, healthy surroundings. These should not be confined to the outskirts of our towns—they must be brought to the centre of them.

Let the Government give the lead we ask, let the necessary laws be passed to enable the Local Authorities to carry their smoke campaign to the "second front"—and we shall not stop until we hit the Giant Squalor for six and have him and all his sooty Luftwaffe in the bag. We shall no longer look with envy at the pictures of clean and beautiful cities abroad. "Britain Can Make It".

Clean the Buildings.

As the central areas or other parts of cities are progressively cleared of smoke emission, is it too much to hope that the old and grimy buildings remaining in them should be cleaned outside ? In some cities abroad this is regularly enforced by law at intervals of eight or ten years. In that way our towns will be pleasanter and more attractive places both for their own citizens and for business and other visitors—and the advantages of smoke prevention will be more apparent. Perhaps in some cases—e.g. a Cathedral or other building of special public interest the cost or part of the cost of cleaning could be borne by the public.

The Society.

Something now about the future of our own Society. The new Constitution is working well—and the first Divisional Council—in the N.W. Division has been set up. The coming year should see the setting up of several more such Divisional Councils—and we hope a very great increase in membership, following local activities. There are many more local authorities to come in—the advantages of membership are perhaps most obvious in their case. We must make membership as attractive as

possible to individuals. They are already kept in touch with smoke abatement progress through "Smokeless Air" and other publications. We may suggest, now that the paper shortage is less acute, that they should be put on the mailing list of manufacturers of smokeless fuels and appliances—and possibly receive some preference as customers. Could some of our influential members who are in a position to do so, gas and electricity undertakings for instance, assist our membership drive by displaying the Society's poster giving membership particulars and having available forms of enrolment, and possibly even by allowing enrolment of members of the Society to be made at their offices, and the names and subscriptions pasesd on to Divisional Treasurers or to Chandos House. The Society is resuming and will soon be intensifying its propagandist activity—and Divisional organizations can be of the utmost value in this—arranging lectures and exhibitions in their areas, meetings of our own members in the division and joint meetings with other interested societies, encouraging smoke abatement teaching in schools, collecting and reporting information concerning local progress and complaints of particular smoke nuisances, and enlisting the co-operation of the local press. An important matter for divisions is the choice of a good secretary who can be relied on to maintain initiative in the Division and provide an office, thus relieving the burden in this respect on the General Secretary and central office of the Society. The Division is in fact simply the Society itself operating in a particular area. Its members, its funds, are those of the Society. The Society will need shortly an annual income of £10,000 if its work is to go on as it should. May we not also hope through the Divisional Associations to secure an individual membership of not less than 10,000 ?

DISCUSSION

The Chairman, Alderman J. Talbot Nanson (Brighton) in opening the session said : Mr. President, Ladies and Gentlemen, I feel I should explain why I am privileged to occupy the Chair of this meeting for your final Session. Yesterday morning the Mayor of Brighton informed you that he was opening and welcoming his 27th and last Conference this municipal year, which terminates on November 9th. That day a new year commences and the first Conference will visit Brighton on the 10th. It has been my duty and pleasure, on behalf of my Committee, to recommend to the Council that invitations should be extended to each of those twenty-seven Conferences and when Mr. Marsh—who has worked so untiringly for the success of this Conference which it must have been as it is the largest you have ever held—invited me to preside at one of the Sessions I thought it appropriate that I should choose the final meeting of the last Conference to be held in Brighton during the present municipal year. All the more appropriate because, during the present week there has been held in the Dome a very important national Conference, a five-and-a-half hours monthly meeting of the seventy-six members of the Brighton Town Council and speeches in connection with the municipal elections in nineteen wards, and as a result there has been more gas and smoke in Brighton during the present week than in all the preceding forty three weeks. Some may have considered it was of small importance to hold this Conference in a town where we know little of nuisance caused by smoke and where for two days you have been enjoying the "champagne air" of Brighton. But what of the future ? Industry is spreading and must spread, extending from the overcrowded areas in the North and

Midlands and eyes are turning toward the South Coast. In Brighton we are to have industries, mostly of a light description, and rightly so; we shall welcome them, as I am certain all our neighbours will do. Is it not therefore necessary that each Local Authority should in its own interest watch carefully that there is no pollution from smoke into areas which have thus far been exempt? Smoke prevention is as important as smoke abatement. In fact I might distort an old adage by saying "Prevention is better than abatement." The building of new houses, blocks of flats, etc., all call for the same watchful eye. The good work done by the Society in the past must not be undone by the possible transfer of the smoke problem from old areas into new ones, and so I hope that any of our neighbouring Authorities who are not members of this Society at the moment—and I am informed that few of them are—will join and strengthen your ranks in the battle still ahead. For these reasons surely your visit is justified. Repeatedly I have said "you" and "yours," forgetting that for some years I have been the representative of the Brighton Corporation on this Society—our Society.

Yesterday I was interested in the discussion concerning the status of the stoker and firemen. As a Warden of the Worshipful Company of Plumbers in the City of London, I wondered whether it would not be possible to introduce a Registration Scheme similar to our own. By this means the National Registration of Plumbers has a system of apprenticeship, whereby a certificate is awarded to the apprentice after he has passed his exams.—and is thereby enabled to add the initials R.P. after his name, proving to his employer that he is a man capable to do the job and being satisfied himself that he is capable and efficient to carry out the job. In his presidential address Sir George Elliston spoke of the anxieties of a certain gentleman. May I suggest that this Society need have no anxiety about its future activities with Sir George Elliston at its head?

Dr. C. F. White (City of London) in opening the discussion, said that he was sure the delegates would wish him to express to Mr. Gandy their appreciation of his excellent paper, which was a very valuable contribution to the proceedings of the Conference. Dr. White understood that he was to speak of the future plans for smoke abatement in the City of London, but he wanted to link his remarks with observations on points which Mr. Gandy had raised in his paper. Mr. Gandy appeared to consider that the future of smoke abatement depended on the creation and extension of smokeless zones, but he said: "the only plan is to take it piecemeal—progressively—clearing the ground as we go." Dr. White was whole-heartedly in agreement with this attitude. He did not remember who coined the phrase "the inevitability of gradualness," but he was certain that it was applicable to smoke abatement.

It had been suggested that little had happened as the result of the activities of the Society during the last 30 years: he would only ask what would have been the situation to-day if there had been no smoke abatement campaign? Some of them were apt to be deceived by the mirages created by "hot air" and to rush forward only to be disappointed. They had heard many of the difficulties which the campaign against smoke, both domestic and industrial, had to face at the present time, and we could not expect a sudden transformation; indeed he felt that though the term "smokeless zone" was snappy and had "caught on," it did not convey the idea of a steady extension from quite a small area to a larger and larger one. He preferred the term "non-smoke producing zone." It would be a long time before there was a really smokeless zone in any urban area because, even if the area produced no smoke, smoke would drift into it, or over it, from neighbouring areas, and the term smokeless zone might therefore come to be ridiculed. The Corporation of the City of London had included powers to declare smokeless zones in their recent Various Powers Bill, but in spite of all he could do, the impression had been created that it was the intention to declare the whole of the City a "smokeless zone." As there were in the City several railway termini, a busy section of the River Thames, and a large brewery which fortunately had survived the blitz, there was strong opposition to the proposal. The opponents were not satisfied with an assurance that the declaration of a smokeless zone would begin with a reconstructed blitzed area and would only be extended as was both reasonable and practicable. In

view of the fact that it was likely to be some years before reconstruction in the City got underway, it was felt that the smokeless zone clause of the Bill could be dropped for the present and be taken up later, when there was perhaps experience of such legislation elsewhere. The Corporation had however obtained powers to make byelaws requiring prior approval of all new or extensively altered fuel-burning appliances and these powers should at least ensure that only smokeless heat-generating plants were installed in the rebuilt areas of the City. Dr. White noted that Mr. Gandy was in favour of national and regional Smoke Control Authorities and stated that "the proper regional organization of smoke control under statutory boards would demand the service of many highly trained consultants, inspectors and others with expert knowledge." Dr. White was of the opinion that local authorities could manage their own smoke abatement problems provided they had easy access to expert opinion in any difficulty. The local authorities could be perfectly efficient general practitioners provided they could call in consultants in difficult cases, Probably the Fuel Research Department of the Ministry of Fuel and Power could organize a consultant service. In any case he was opposed to the idea of a large increase in the number of inspectors. This country was heading for a state of affairs where half the population was inspecting the other half either directly, or indirectly through forms of one sort or another. What we needed above all was producers of food, of clothing, of consumer goods and of things we could sell to pay our debts.

In the matter of district heating, the City of London was looking to the future. As the audience probably knew, about one-third of the City had been destroyed and much of the destruction was in three concentrated areas where all the buildings were down to basement level. The Corporation, at the instigation of Sir George Elliston, had resolved that the question of supplying these areas with hot water for central heating and domestic purposes, on the District Heating system, was worthy of consideration and had engaged a distinguished consulting engineer to prepare a scheme. Dr. White had no information as to the views of the consultant, but it appeared to him that aggregations of commercial buildings such as would in due course be erected in the devastated areas were eminently suitable for a District Heating Scheme. The requirements would be more easily calculated than in a housing area, and the mains would be shorter. He thought that the owners of buildings would welcome the release of valuable space which would otherwise have to be devoted to individual central heating plants. He understood that a heat-electric system was the most economical, but they had no electricity generating stations in the City. Perhaps it might be possible to erect stations which were primarily for district heating, but where electricity was generated as a by-product and sold to the Central Electricity Board. If they had district heating stations they could control the emission, not only of visible smoke, but also of sulphur compounds, which were at least as important as a menace to health and a cause of damage to buildings, etc.

Professor F. E. Tylecote (Manchester) said he first of all wished to congratulate Mr. Gandy on a most excellent paper, the points made in which would help so much in the struggle before them. He then said that before dealing with the smoke clauses of Manchester's new omnibus Act (1946) he would like to give one or two facts which would be useful to members when addressing meetings or on similar missionary occasions. He referred to the high death rate from respiratory diseases, 1 in 6 or even 1 in 5 in the smoke-laden areas, and to the further fact that 1 in 5 of all "national health" sickness notes were "respiratory." Where death rates were high from these causes the infantile death rate was also high. In 1926, the year of the General Strike. the bronchitis deaths in Manchester fell from 1,279 (1925) to 996, a fall of 22.13%. The actual bronchitis death rate for Manchester was in 1925 1.69 per 1,000, in 1926 it was 1.32 per 1,000. But they must never forget that death or mortality rates were not incidence rates, as the sick notes figure given above showed. Patients with catarrh, bronchitis, asthma and emphysema often did not seek help until the condition was well-established and was really worying them. Smoke was one of the predisposants to these conditions. Carbon particles themselves might do the lung parenchyma no harm, but gritty ones (grit was included in the definition of "smoke")

did. It was noticeable in the central streets of Manchester in the General Strike that one could see distant hills which had never before been visible from these points. Manchester was situated in a sort of saucer or depression and it was very difficult for the smoke to get out. "It's a gradely city, ba gum it is, but a fair dirty 'un"—and the rain must be sent by Providence to help them to clean up the dirt. Dealing with the Manchester Corporation Act, 1946 and how it was hoped to implement the smoke provisions therein Professor Tylecote said the smoke provisions of the Act came under three main headings, i.e., smokeless zones, prevention of smoke from new industrial furnaces, and district heating. These provisions represented the first statutory enactments of their kind in the country, but it was worthy of note that in the Manchester Police Act of 1844 there was a clause designed to compel furnaces to consume their own smoke. A central smokeless zone was defined. It is fortunate that no railways existed in the defined area. If the area was extended at all in the future it must contain railways; therefore a primary necessity must be the electrification of all railways. The provisions of that part of the Act did not apply to smoke coming in from railway locomotives; power was taken to extend the area and to exempt certain premises or to defer the operation of any order in the case of certain premises and specified industrial processes if the Minister was satisfied that the inclusion of the said premises would obstruct the processes named (mining and metallurgical). The smokeless zone clause was not operative until:

(a) the Corporation had consulted the Ministry of Health, and
(b) The Council had then resolved to declare the smokeless zone area, after giving 12 months' notice of the specified date and conditions.

Prevention of Smoke from Industrial Furnaces. This clause was operative from the date of the passing of the Act. It made provision for all new industrial fuel burning appliances and plant within the city to be approved by the Corporation before installation. This was to ensure that as far as practicable (and having regard to cost, local conditions and circumstances) all such furnaces, etc., were capable of being operated continuously without emitting smoke.

District Heating. This section gave the Corporation the necessary basic powers in connection with district heating in the Wythenshawe area. Full details of the scheme were given in a special report of the Housing and Wythenshawe Estate Special Committee and considerable information regarding it was also contained in the "City of Manchester Plan." Briefly one might say that it was planned to provide low pressure hot water and heating to 7,945 houses at a cost of £1,620.942 charging an average of 5s. 1d. a week. Two boiler houses were proposed, one in each industrial zone. The medium for the distribution of heat from the boiler plants to the dwellings was by means of hot water circulated by pumps situate (i) in the boiler houses and (ii) in a number of sub-stations. The mains to the buildings were all placed below ground and in suitable conduits and ducts. It would not be necessary to burn raw fuel in the district concerned except at the central sources of heat generation. A provision was inserted that the Corporation should not create or permit a nuisance in connection with the district heating undertaking. Finally he submitted that the enactments were such as to continue to keep Manchester in the forefront of the smoke abatement campaign.

Alderman E. T. Cozens (Bristol) said there was one point to which he thought it would be helpful to call attention. That was that the Government should give them a lead; he was sure the right line to adopt was that the local authorities should demand from whatever government was in power that the question of smoke abatement be taken seriously and an Act placed upon the statute book which would make it possible to remove this menace to health and comfort in the shortest time. That would only come when the people demanded it. In the interval they, as local authorities, within their powers, could do quite a lot to pave the way. Perhaps it would not be presumptuous if he detailed some of the steps they had taken in Bristol as their part in the campaign. The need for progress in connection with this matter was foremost in the minds of the Bristol Health Authorities before the outbreak of war. During recent months no opportunity had been lost in reopening the subject with a special emphasis on the **prevention** of smoke

pollution in addition to its abatement. Early in 1945 the work of the Bristol and District Regional Smoke Abatement Council was resumed and in June of that year a meeting of the full Council was addressed by Mr. Arnold Marsh, the Society's Secretary. Interest in this matter rapidly developed and a meeting of Bristol City Council Committee Chairmen and principal officers was convened to review the problem and to set administrative machinery into operation whereby the utmost possible would be done during planning and reconstruction to reduce the amount of atmospheric pollution to the minimum.

Many lines of attack were discussed at this meeting including the possibility of creating a smokeless zone in the Central Planning Area, district heating schemes, communal power plants for the new trading estates, together with the installation of smokeless grates and other approved apparatus in the new houses and buildings to be erected. Following a report of this meeting to the Health Committee, it was decided to send a deputation of three members with the Medical Officer of Health and Chief Sanitary Inspector to wait upon the Planning and Reconstruction and Housing Committees in order that still more attention should be focussed upon this important matter. A sympathetic hearing was given the deputation by the Planning and Reconstruction Committee who gave an assurance that the points raised would be kept foremost in the minds of the Committee and officers responsible for reconstruction. Subsequently the Housing Committee came to the clear decision that approved smokeless fuel grates would be installed in all new houses wherever possible. It should be placed on record that the Bristol Health Committee was very appreciative of the assistance which has been rendered by the National Smoke Abatement Society's Secretary, and it was indeed a pleasure to report that the Health Committee were now considering the possibility of establishing a Smoke Control Committee in the City which now had the importance of clean air most firmly established in the minds of all those responsible for planning and reconstruction arrangements. As a "stop press" report to his contribution he was glad to be able to say that all the representatives of the various interested committees in Bristol had now been formed into a Smoke Control Committee and he suggested this was a lead that could be well followed by other local authorities.

Dr. W. A. L. Collier (Member) said he was fresh to the subject of smoke abatement, but had had occasion to read it up during the last few months and was struck with the relationship between industrial and domestic sources of the smoke nuisance. In the past the housewife had looked out of her kitchen window and seen the black smoke emanating from the factory chimney and had therefore been unamenable to domestic smoke abatement. The industrialist on the other hand had succeeded in quoting figures to show that a large fraction, if not more than half, of the pollution of the atmosphere came from the domestic hearth. This situation would, he felt, be described by George Bernard Shaw as progress standing on its head. What was needed was to reverse the situation and stand progress on its feet by presenting the picture to the public in such a way as to institute a popular demand for a competitive reduction in smoke from these two sources. Dr. Collier went on to describe a practical graphical way in which this could be achieved. He first stressed the importance of sticking to a percentage reduction in smoke from these two causes as opposed to any attempt at deciding the absolute amounts produced by each and suggested that a period of about five years could probably best be made to produce a graph that could be used on posters and be easily understood by the general public, the first year on the graph would be used as the index of 100 per cent. and the relative amounts from the two sources would be plotted separately, but both starting from the same point, i.e., 100 per cent. In this way a popular demand would be created for a reduction in smoke from the most offending source. He admitted that in the past the difficulty would have been to find any figures upon which to calculate this comparison. There was hope however, particularly following the scientific survey of "Atmospheric Pollution in Leicester" that in the future a basis for the calculation of such a comparison would be forthcoming.

Dr. W. R. Martine (Birmingham) said he would like to associate himself with the previous speakers in thanking

Mr. Gandy for his very able paper. He would like, however, to take him up on two points of considerable importance as far as the West Midlands was concerned. Mr. Gandy pleaded for Statutory Committees. He thought Dr. Burn had successfully killed that idea at Leeds, when he routed Mr. Law in open debate. They in the West Midlands wanted more statutory powers vested in the local authority—the regional body in their wide and populous area could do far more on an advisory basis. The other point—Mr. Gandy had asked for training of inspectors and operatives. It was up to him he thought to say that they were again holding a course for Smoke Inspectors in Birmingham, while the Joint Education Committee of the Ministry of Fuel and Power and the Institute of Fuel with the assistance of a few co-opted members established courses for boiler and furnace firemen at several of the technical colleges six months ago and had the training at higher levels now also well in hand. He would like to ask whether any thought had been given to the use of oil for new central heating or district heating projects. The army used this method extensively in Italy—with improvised plant—because of the shortage of other fuels, and with great success from heating and smokeless points of view. He could think of one large hospital of 2,000 beds widely spread out in buildings of not more than two storeys where all cooking, space heating and hot water supply was provided for by adapting the 72-inch ranges and central heating boilers to oil fuel.

Leslie Hardern (British Gas Council) said he would like to feel that every delegate to this Conference was going to leave with the definite impression that he had received his marching orders from the Chairman. He had made an attempt to sort out in his own mind what these marching orders were for the various sections represented. They had been gratified to have with them representatives of the Ministry of Fuel and Power who have told them of the setting up of the Inter-departmental Committee to implement the Simon Report. They had also heard that the Coal Board was going to increase the production of suitable smokeless coals. He was not sure whether it was generally appreciated that the Ministry was also in full control of the gas and electricity industries. This meant that all increases in the production and use of these two smokeless fuels could only be obtained with the active help of the Ministry. From the point of view of the Smoke Abatement Society, the Ministry of Fuel and Power was bound to take a major role. Then there was the Ministry of Health. He was sorry that he had not seen a representative of this Ministry at the Conference, and suggested that the deliberations at our Annual Conferences always justified the attendance of a representative of the Ministry of Health. [*The Ministry was represented—Ed.*] They knew that the Parliamentary Secretary had stated publicly that he was willing to make the installation of efficient fuel equipment a condition of subsidy for local authority houses. This was encouraging, but as the Ministry of Health was so vitally concerned in the health results of smoke abatement, they hoped that they would give them more active support in urging their policy in local authorities and in the field of legislation. The Ministry of Supply was also very important. They were responsible for the production of all fuel equipment. By their control of raw materials and plant, they could ensure the production of approved appliances only. They looked to the representatives of the Ministry of Fuel and Power to urge this course upon them. The local authority representatives at the Conference had heard what the more progressive local authorities were doing and would no doubt, be anxious to go back and do likewise in their own areas. The fuel industries had been asked by Mr. Gandy to join in a drive for new membership. He was sure that his friends in the electricity industry and his colleagues in the gas industry would wholeheartedly respond to that appeal. Speaking for himself, he would start on the proposal of showroom posters and forms of enrolment on his return to London on Monday. What about the women? They had heard at the Conference that they wanted to enlist their help. But what were they doing in their own organizations? Surely it was up to them to see that smoke abatement was placed high on the agenda of the National Council of Women, the Townswomen's Guilds, the Women's Institutes, the W.V.S., the Co-Operative Women's Guild, and the Labour women's organization. Finally, their own Publicity Commit-

tee. Several suggestions for travelling exhibitions had been put forward during the Conference; only that morning an excellent idea was submitted for the use of comparative graphs for editorial articles. He was sure that the Ministry of Fuel and Power would help with the loan of appliances. He hoped they would get on with their publicity work without delay, and come along to next year's Conference with reports on progress.

R. E. Gamlen (Mid-Cumberland Electricity Co., Ltd.) said that many speakers had mentioned the importance of publicity but Mr. Marsh would tell them that this cost money. How were they to get it? The present revenue of an Association of this size and importance was very small. They wanted more members. Could each existing member get two new ones? It was easy to open conversation on the subject of smoke pollution as most people were interested in it. There were those who did not realize to the full the amount of damage smoke could do. For instance, he was asked the other day whether smoke did not help to fertilize the ground. He fully endorsed the last speaker's reference to the importance of interesting women's organizations including the W.V.S. The general cover given by the press to the subject was poor. It was not considered to be of news value The reports of the Conference had been very few. Could they do more to interest the Press and ask the editors and Press lords to become members of the Society? In the provincial Press local Councillors could help generally by seeing that their speeches on smoke abatement were fully reported. He assured Mr. Gandy that the undertakings which he represented as well as others would be only too willing to help by displaying the Society's posters and giving membership particulars.

Councillor H. Stewart (Urmston) said that several points had been mentioned which Urmston's experience disproved. The first was that a purely heat station with no connection to so-called waste heat would be a practical proposition. Second, it was stated that special Acts of Parliament were necessary. For a new district, that would not be the case. Urmston had satisfied the Ministry of Health and Ministry of Fuel and had already commenced on actual construction. The scheme was designed to grow in stages, from 60 to 150 houses, then to 200, later to 600 and finally to 1,300 houses, with 17 public buildings. A temporary boiler plant located in one of the permanent garages and fitted to supply the first 20 houses was actually in operation and serving the first small group of bungalows a fortnight ago. So, far from delaying the work it had expedited by the adoption of the scheme. The costs appeared to be reasonable, though final costs would not be given until a further section had been let. The Council anticipated having between 150 and 200 houses in operation early next year, which proved that schemes could be started without waiting for a large number of houses to be connected. Enquiries had been received from existing houses adjacent to the site to see if the scheme could be extended to include them, and this matter was being investigated, which was proof that there was a demand for these facilities. Unquestionably district heating supplied the best and easiest solution to the smoke problem at the present time. The charges for district heating's services were as follows:

Old age pensioners' bungalows—3s. per week.

4 bedrooms, house of nearly 1,000 sq. ft.—5s. and 5s. 6d. per week.

Smaller houses at a weekly rate between the previous two.

For these charges, heating and constant hot water at a temperature of approximately 140° F. was supplied to the extent of from 35-38 gallons per day. Councillor Stewart was pleased to say that Urmston was the first in the field in this connection, not only with theories and proposals for the future, but in having the scheme already in operation. The distance between the two extremities of the Flixton Housing Scheme, in which the district heating was incorporated, was a little over a mile.

Donald V. H. Smith (Member) said that throughout the conference there had been many hard words said about both industrialists and the Government, and to some extent he thought the Society was barking up the wrong tree. Industrialists for their own sake, must, with the present price of fuel, strive after efficiency, and the nearer they approached to it the closer they were in line with the objects of this Society. The real culprit in smoke pollution was the domestic chimney and there too, to

save fuel, the Government had recently gone a long way in the direction this Society desired. There were two publications on the bookstall, one of them free, which appeared to have had little demand, which dealt with this very problem, but instead of asking the Government to compel local authorities to act the onus was on local authorities to use the powers they already possess. It was not necessary for instance to get an Act of Parliament, in order to go ahead with District Heating in new estates. The Ministries concerned had appointed an inter-departmental committee to deal with the very subject, and from personal experience on several proposals recently, he could say that far from doing nothing, they had been very helpful and indeed in some respects were in advance of the Society's activities. If local authorities did not know where to go for technical advice, he was sure an enquiry to either the Ministry of Health or of Fuel, would get them the information promptly. He was a bit dubious of the perpetual call for the central Government to act. He would rather see more activity by the local authorities, and even if 50 per cent. of them did the wrong thing they would soon learn from the 50 per cent. who were successful, whereas if they depended on a single central administration an error in policy might hold up progress indefinitely. In view of the recent schemes approved by the Inter-departmental Committee he had mentioned, and their willingness to assist and consider in any schemes proposed by the local authorities, it was a little ungenerous to be continually baiting the Government and ask for new coercive laws to be enacted. Let the local authorities get busy themselves and use the powers they already had.

A. F. Williams (Ministry of Fuel and Power) said that he would like to make known to the Conference the extent of the activities of the Fuel Efficiency Branch of the Ministry. He said that the aim and purpose of the National Smoke Abatement Society were by no means at variance with the policy of the Ministry of Fuel and Power: in fact, smoke abatement was but one aspect of the larger question of efficient fuel combustion and that if one succeeded in the larger purpose of fuel efficiency, smoke abatement would automatically be achieved. The Fuel Efficiency Branch, through the Fuel Efficiency Committee set up to advise the Minister, had done a considerable amount of work, both on the practical and on the educational side. *Ad hoc* courses of instruction had been given at Technical Colleges and no fewer than 23,000 students had attended these Ministry-sponsored courses.

In each of the twelve defence regions there was a Fuel Efficiency Committee, with its Education Sub-Committee, and recently these Regional Educational Committees had merged with the District Education Committees of the Institute of Fuel, to form Regional Joint Educational Committees. The Institution of Gas Engineers had indicated their desire to be represented on these Joint Committees. Moreover, arising out of consultations with the City and Guilds of London Institute, an elementary syllabus of instruction in boiler house practice had been approved. That course was of a practical nature. A simple examination at the end of the course would entitle each successful candidate to a certificate given by the Technical College at which the course was held. The examination would be supplemented by further practical tests by the Ministry's Engineer or Stoker/Demonstrator, these tests being carried out on the candidate's own boiler plant. This elementary course would lead up to the normal City and Guilds two-year course in boiler house practice and combustion engineering, thence to advance courses and finally to associate membership of the Institute of Fuel. There was thus a continuous educational ladder from the firing floor to the chartered fuel technologist. The Fuel Efficiency Committee had published one text book on "The Efficient Use of Fuel"; would shortly publish a companion volume on "The Efficient use of Steam"; had published 46 technical bulletins and issued a monthly broadsheet entitled "Fuel Efficiency News," with a circulation of something like 40,000. On the practical side visits to factories by Ministry's Engineers had reached the grand total of 60,000. The domestic aspects of fuel economy were also fully taken care of through Regional Fuel Efficiency Organizers. These Organizers, all of whom were women, were responsible for the education of fuel users in the home, and for giving instruction in the use of modern fuel burning appliances. Information Centres were being set up, the first of which would be at London

and Glasgow. Mr. Williams also mentioned the Conference "Fuel and the Future" held in London during the early part of October. Turning to supply difficulties, Mr. Williams said that those present should appreciate the difficulties that were experienced by Government departments in keeping the steady flow of materials required for the conversion from war to peace. They were in need of more ships, more houses, more food, plant and equipment of all kinds, more raw materials, and more consumer goods. The only thing we needed less of was smoke!

The difficulty of the central administration was to preserve that balance between one need and another, and whilst enthusiasts for smoke abatement might feel that the highest priority should be given to the production of equipment that would mitigate this nuisance, demands no less urgent and pressing were made by other sections of the community. Within the limits of manpower and materials, what could be done to speed up matters was being done. On district heating, Mr. Williams said that the departments concerned did not need to be convinced of the merits of this form of heating. On the contrary, they were doing everything possible to stimulate its adoption in relation to new housing estates. Three schemes had already been approved by the Inter-departmental Committee set up to consider these matters. Other schemes were the subject of consideration and many more were known to be coming forward. A joint memorandum on "District Heating as Applied to Small Housing Estates" had been prepared by the Ministry of Fuel and Power and the Ministry of Works, and this publication was available free of charge at the bookstall of the Conference. The Egerton Committee on District Heating had brought its labours to an end and its report would soon be issued. It was up to Local Authorities to show that they were prepared to venture into these new methods of heating. They could be assured that they would receive every support from the departments concerned.

Resolutions. The resolutions then considered and adopted are recorded on the following page.

J. W. Beaumont (Vice-Chairman, Executive Council) proposed that a cordial vote of thanks be extended to all who had contributed to the success of the conference, and referred especially to the Mayor and Corporation of Brighton, Councillor Miss D. E. Stringer, Alderman J. Talbot Nanson, the Brighton Publicity Committee and Mr. C. G. Browne, Director of Publicity, Mr. A. E. Lowry, the Mayor's Secretary, Major Jupp of the Royal Pavilion, Mr. A. Howard Holt, Housing Manager, who had kindly made possible the duplication at short notice of the resolutions, Mr. H. Pryce-Jones, Engineer and Manager, Brighton Electricity Department for the invitation for a party to visit the Southwick Power Station that afternoon, and the Society's Secretariat.

David Grant (Executive Council) seconded the vote of thanks, which was then carried with acclamation.

The Chairman, **Alderman J. Talbot Nanson,** in declaring the session and Conference closed, said on behalf of his colleagues, the Mayor of Brighton and Councillor Miss D. E. Stringer (Chairman of Brighton Corporation Health Committee) how delighted they had been to welcome the Society and should be at all times, whether coming for a conference or visiting them as individuals seeking fresh air and entertainment.

RESOLUTIONS

Proposals for resolutions submitted by members of the Conference were considered and correlated by a sub-committee of the Executive Council, on behalf of whom the following five resolutions were proposed. These were duly seconded and carried.

1. That this Conference of the National Smoke Abatement Society views with grave concern the menace to health and amenities caused by the emission of smoke, sulphur and grit from certain electricity generating stations and calls on the Ministry of Fuel and Power and the Central Electricity Board to take immediate steps to obviate the nuisance.

2. That this Conference of the National Smoke Abatement Society requests H.M. Government as a matter of extreme urgency to give a higher priority to the production of efficient smokeless fuel burning appliances, and requests that the payment of subsidy to housing authorities be conditional on the installation of such appliances as soon as they are available.

3. That this Conference of the National Smoke Abatement Society extends its good wishes to the National Coal Board, and is gratified to learn that a progressively increasing production of smokeless fuels is to be in the forefront of its programme, and trusts that, in the interests of both fuel efficiency and smoke prevention, an early start will be made towards the complete disuse of bituminous coal for all domestic purposes.

4. That this Conference of the National Smoke Abatement Society endorses the appeal made in his Presidential Address by Sir George Elliston to all local authorities that are not yet members of the Society to add their strength to the campaign against the nation-wide evil of smoke by becoming members.

5. That this Conference of the National Smoke Abatement Society accepts in principle the proposals for new legislation for Industrial Smoke Prevention, requests the Executive Council to reconsider them in the light of the discussion at this conference, and to take appropriate action.

The following resolution was proposed by Councillor Duffus (Bexley) and seconded:

That this Conference of the National Smoke Abatement Society urges local authorities to take summary action against all offenders against Section 92 (1) (d) of the Public Health Act, 1936.

After discussion the following amendment was proposed and seconded:

That this Conference of the National Smoke Abatement Society instructs the Executive Council to consider in detail this resolution in consultation with the appropriate local authorities.

On a vote the amendment was carried and the resolution not carried.

OTHER N.S.A.S. PUBLICATIONS

(*see also inside front cover*)

Smokeless Air.

The Society's quarterly journal. The only magazine in the world devoted to the problems of atmospheric pollution. Gratis to members, or **2/6d.** a year, post free.

Law of Smoke Nuisances.

By W. R. Hornby Steer, M.A., LL.B., Recorder of South Molton, Standing Counsel to the Society. This book, based on an earlier work by Randolph A. Glen and revised and extended in accordance with the Public Health Acts, 1936, may be accepted as a standard work on the subject. In addition to explanatory chapters it contains tables of statutes and the relevant sections from the two Acts and the Local Government Act, 1933. 8vo. 64 pages. **1/-** paper covers; **2/6d.** cloth-bound.

Fumifugium : or the Smoke of London Dissipated.

By John Evelyn. This fascinating book, first published in 1661 by command of Charles II, has been re-published by the Society with an introduction by Rose Macaulay and original woodcuts. This classical indictment of the smoke evil by the author of the famous Diaries remains true, witty and penetrating. **6d.,** paper covers ; **1/6d.** cloth-bound.

To be Published Shortly

N.S.A.S. REPORT, 1947

Containing the Society's Annual Report for 1946 ; lists of Officers, Local Authority Members ; information about the Society and services available to Members ; Subscription list and Statement of Accounts for 1945-46, etc.

Price **3d.** Gratis to Members and Representatives

THE

14th ANNUAL CONFERENCE

1947

of the National Smoke Abatement Society will be held, by kind invitation of the Lord Provost and Corporation, from 1st or 2nd to 4th October, 1947, in the City of

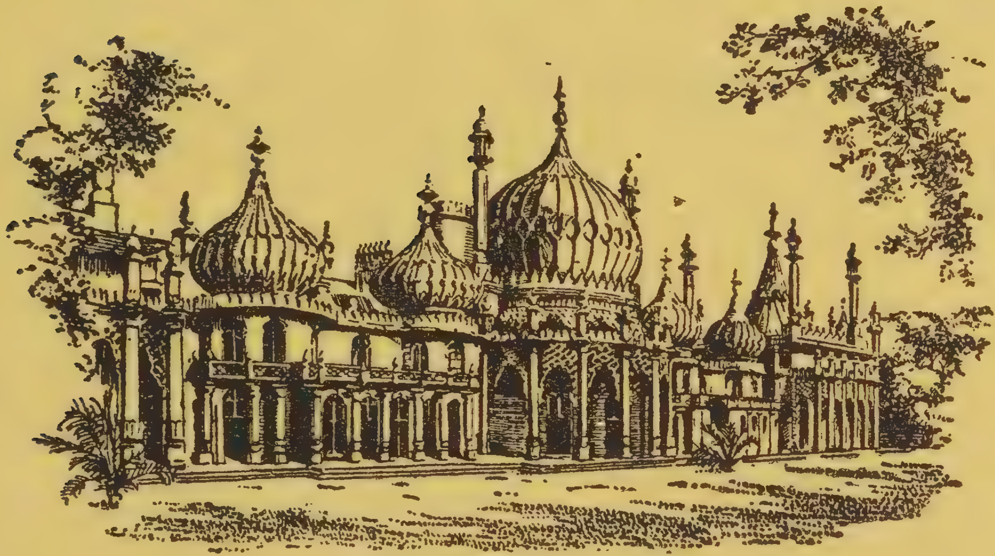
EDINBURGH

Galbraith King & Co., Ltd., Printers, 101, Leadenhall Street, E.C.3.

NATIONAL SMOKE ABATEMENT SOCIETY

PROGRAMME
of the
13th Annual Conference

BRIGHTON



In the
ROYAL PAVILION

Thursday, 24th October

to

Saturday, 26th October

1946

PROGRAMME

THURSDAY, 24th OCTOBER

4.30 p.m. **The Presidential Address**

by

Sir George Elliston, M.C., M.A., J.P., D.L.

* *At the conclusion of this meeting a Special General Meeting of the Society will be held. For Members and Representatives of Members only—see separate notice.*

8.00 p.m. **Assembly and Reception**

By Invitation of the President and Executive Council

Refreshments — *Music* — *Films*

FRIDAY MORNING, 25th OCTOBER

9.30 a.m. **First Conference Session**

?

Chairman: The President, Sir George Elliston

Welcome to the Conference by His Worship the Mayor of Brighton (Councillor Walter Clout, J.P.)

Smoke Prevention in New Houses

Regional Reports, based on replies to questionnaires submitted to Local Authorities, will be presented as follows :

1. *Scotland.* By Allan W. Ritchie, M.B.E., F.R.San.I. (Chief Sanitary Inspector, Edinburgh; President, Scottish Division, N.S.A.S.)
2. *North-East.* By A. Stuart Hebblethwaite, M.C., M.B., Ch.B., D.P.H. (Medical Officer of Health, Sunderland).
3. *North-West.* By C. Metcalfe Brown, M.D., D.P.H. (Medical Officer of Health, Manchester; Hon. Secretary, Manchester and District Regional Smoke Abatement Committee).
4. *Yorkshire.* By J. Johnstone Jervis, M.D., D.P.H. (Medical Officer of Health, Leeds; Hon. Secretary, West Riding of Yorkshire Regional Smoke Abatement Committee).
5. *Sheffield and District.* By James Law (Chief Smoke Inspector, Sheffield, Rotherham and District Smoke Abatement Committee).

6. *West Midlands.* By W. R. Martine, O.B.E., T.D., M.D., D.P.H. (Assistant Medical Officer of Health, Birmingham; Hon. Secretary, Midlands Advisory Council for Smoke Abatement).

7. *East Midlands.* By Alfred Wade, F.R.San.I. (Chief Sanitary Inspector, Nottingham).

8. *Bristol and District.* By F. J. Redstone, F.R.San.I., F.S.I.A. (Chief Sanitary Inspector, Bristol; Hon. Secretary, Bristol and District Regional Smoke Abatement Committee).

9. *Greater London.* By H. G. Clinch, F.R.San.I., F.S.I.A. (Housing Director, West Ham; Chairman, Greater London Advisory Council for Smoke Abatement), and Clifford Ratcliff (Hon. Secretary, Greater London Advisory Council for Smoke Abatement).

10. *Other Areas.* Compiled by the Society.

11.45 Discussion.

12.30 Close of Session: Lunch adjournment.

FRIDAY AFTERNOON, 25th OCTOBER

2.30 p.m. **Second Conference Session**

Chairman: Councillor Miss D. E. Stringer (Chairman of the Health Committee, Brighton).

Proposals for New Industrial Legislation

The Proposals, submitted by the Executive Council, and published in printed form, will be discussed, with opening papers as follows:

(1) *By a Fuel Technologist* (Sidney N. Duguid, B.Sc.Tech., F.Inst.Fuel, F.R.San.I.).

(2) *By a Smoke Inspector* (George W. Farquharson, Chief Smoke and Factory Inspector, Birmingham).

(3) *By an Industrialist* (Herbert A. Humphrey, M.I.C.E., M.I.Mech.E., M.I.E.E., M.R.I.).

(4) *By a Stoker* (E. Bowles, National Union of Municipal and General Workers).

Discussion.

5.00 Close of Session.

FRIDAY EVENING, 25th OCTOBER

8.00 p.m. Reception by Invitation of His Worship the Mayor of Brighton.

Dancing — *Refreshments*

SATURDAY MORNING, 26th OCTOBER

9.30 a.m. **Third Conference Session.**

Chairman : Alderman Talbot Nanson (Chairman of the Publicity Committee, Brighton).

What of the Future ?

(*Smokeless Zones—New Legislation—the Domestic Fuel Policy Report—Fuel Control*, etc.).

? Paper by Charles Gandy (Chairman, Executive Council, N.S.A.S.)

Opening contributions to the discussion on what is being planned in the City of London, Manchester and Bristol, by :

Dr. C. F. White, O.B.E. (Medical Officer of Health, City of London).

Professor F. E. Tylecote, M.D., F.R.C.P. (Deputy Chairman, City of Manchester Public Health Committee).

Alderman E. T. Cozens (Vice-Chairman, City of Bristol Public Health Committee).

General Discussion.

11.30 Consideration of any Resolutions.

Votes of Thanks.

12.00 Close of Conference.

Please Read Carefully

ARRANGEMENTS AND INFORMATION

Meeting Place. All meetings and the receptions will be held in the Royal Pavilion.

Other Documents. Either with this programme or on or about 18th October delegates will receive a Map of Brighton, Conference Badge, Brighton Identity Card, and Advance Papers. Reception Invitations will be sent to those who indicate on the enclosed Reply Form that they wish to attend.

Advance Papers. Advance copies of the papers to be read, as far as they are received in time for printing, will be posted, with any other material, on or about 18th October. Any papers that cannot be forwarded in this way will be available at the Bookstall. The Presidential Address will not be published in advance.

Reply Form. Kindly complete and return the enclosed form as soon as possible in order to facilitate the arrangements and ensure receipt of Invitation cards.

Receptions. If you wish to receive tickets for the Receptions for yourself and a Lady (or for Gentleman in the case of Lady delegates) please indicate this on the Reply Form. Evening dress will *not* be worn at either Reception.

Conference Badge. The wearing of the Badge at meetings is requested in order to assist introductions to other delegates.

Identity Card. The Brighton Corporation Identity Card entitles the holder to the privileges indicated on the card. One further card may be obtained on request for a delegate's friend.

Discussions. Participation in the discussions at the Conference sessions will be open to all delegates, but those who have indicated their desire to speak will be called on first. In view of the fact that discussions at smoke abatement conferences have invariably to be cut short, all speakers are requested: (a) to condense their remarks as much as possible and in no case to exceed 5 minutes; and (b) to confine their remarks strictly to the specific aspect of the problem then being discussed.

Proceedings. The papers, discussions, and any resolutions will be subsequently published in volume form as *The Proceedings of the Brighton Conference*. A copy will be forwarded free of charge to all accredited delegates, and extra copies will be available at 2/- each, post-free.

Those who take part in the discussions are asked to send a copy of their remarks to the Secretary not later than 8th November, or to hand them to a member of the Staff at the

conference itself. Verbatim reports of speeches will *not* be taken.

Bookstall. There will be a Bookstall of the Society's and other publications at the Royal Pavilion. A list of members and delegates registered as attending will be available for reference.

Inquiries. Inquiries about arrangements and requests for information (other than about hotel accommodation, which cannot be dealt with) should be addressed to the Society's offices up to Wednesday, 23rd October, and during the Conference either at the Royal Pavilion or at the Glenside Hotel, Grand Parade. Assistance with regard to hotel accommodation should be made to Hotel Bookings and Information, Ltd., 20, West Street, Brighton. (Special booking fee on mentioning the Conference, 3/-).

1947 Conference. An announcement on the place and date of the 1947 Conference will be made during one of the sessions.

National Smoke Abatement Society,
Chandos House,
Buckingham Gate,
*Westminster, S.W.*1.
Telephone: *ABBey* 1359.

ARNOLD MARSH,
General Secretary.

Previous Conferences of the Society

1929	Buxton
1930	Leicester
1931	Liverpool
1932	Newcastle-upon-Tyne
1933	Sheffield
1934	Glasgow
1935	Bristol
1936	London (Science Museum)
1937	Leeds
1938	Cardiff
1943	London
1945	London

NOTES.

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NATIONAL

SMOKE ABATEMENT SOCIETY

PROCEEDINGS of the EDINBURGH CONFERENCE 1947

Price : 4/6d.

CHANDOS HOUSE
BUCKINGHAM GATE
LONDON S.W.1

Recent Publications of the Society

Proceedings of the Brighton Conference, 1946. A full record of Papers and Discussions. The principal subjects covered are Smoke Prevention in New Houses, Proposals for New Industrial Legislation, and "What of the Future ?" 84 pages 2s.

Proposals for New Legislation. Revised draft of the Society's proposals for new legislation (Prior Approval, etc.). 8 pages 6d.

Constitution. The new constitution of the Society in booklet form, as revised 1946 and 1947. 8 pages 2d.

New Edition in Preparation

The Law of Smoke Nuisances. By W. R. Hornby Steer, M.A., LL.B., Recorder of South Molton, Standing Counsel, N.S.A.S. This book is based on an earlier work by Randolph A. Glen, and fully covers the law as it applies in England and Wales under the Public Health Acts, 1936. In addition to Chapters on History, the Common Law, Private Houses, Trade Premises, London, Shipping, Railways, Vehicles, and Joint Action, it contains tables of statutes and cases and the relevant sections from the Public Health Acts and the Local Government Acts, 1933, in verbatim. The revised edition now being prepared will include material on the important City of London (General Powers) Act, 1946 and the Manchester Corporation Act, 1946, in each of which the new policies for smoke prevention are reflected. Cloth-bound 5s. 0d., Paper-backed 3s. 0d.

Published by Faber & Faber, Ltd.

Smoke : The Problem of Smoke and the Atmosphere. By Arnold Marsh. In its first part, this new book brings together and discusses the data on which rests the case against smoke. The second part reviews what has been done, the present position, and means for securing the progressive abolition of smoke. With full bibliography and references. 306 pages, plus 21 photographs. 21s. net. By post 21s. 6d.

(*See inside back cover for other publications*)

NATIONAL SMOKE ABATEMENT SOCIETY

PROCEEDINGS of the EDINBURGH CONFERENCE

1st to 4th OCTOBER, 1947

CHANDOS HOUSE, BUCKINGHAM GATE, LONDON, S.W.1

CONTENTS

B1

General Meeting

Presidential Address

By SIR GEORGE ELLISTON, M.C., M.A., J.P., D.L.

THIS is the second occasion on which the Annual conference of the Society has been held in Scotland —the first was in Glasgow in 1934—and we are very glad indeed to be here again, and especially glad to be in this incomparable city of Edinburgh. After the great and successful Festival of Music and other Arts that has just ended, a conference on smoke abatement may seem to be excessively sombre and utilitarian. We can, however, assure the citizens of Edinburgh that if they wish to see their great new festival increase in attractiveness and fame, they must take our subject of smoke far more seriously than they have yet done. To them I would suggest that their city must be not only proud, but fair and clean to look upon. How much would have been gained if, during the lovely sunny summer we have so much enjoyed, their buildings, monuments and streets had gleamed clean and white, instead of seeming dark, grimy and forbidding.

Perhaps more than any other city in Britain, Edinburgh has the most to gain by abolishing smoke and all its attendant evils. And it is by the fullest use of the most modern gifts of science and technology that the beauty and grace of the past, so well represented here, can be preserved and enhanced. The purpose of our meeting is to discuss and show how this can be done.

We must not, of course, forget that we are guests, and become too exhortative with our hosts—although we are sure they will appreciate that the more worthy the object of one's admiration, the more distressing it is to see it spoiled by blemishes. Edinburgh, far more than her plainer sisters, cannot afford to look drab and dingy.

But this is not the only place in Scotland that suffers from smoke, and we must not give the impression that it is our concern only. Clydeside and all the industrial belt have problems equally and even more extensive, while in the coalfields there is the added trouble from what in England we call burning pitheaps, but which in Scotland are known as bings. And even the Highlands are not free. Not only do they catch much of the grime that comes from the south-west and south, but their own towns are not without guilt. Only this last month—and quite without any prompting from our Society—an indignant citizen of Inverness wrote to the Press to complain that "it is a tragedy that in the capital of the Highlands we are forced to take smoke instead of clean fresh air into our lungs."

The fact that our national Society comes to Scotland so rarely is perhaps due to the fact that our Scottish Division does so well by itself. They are our senior Division, and, composed of local authorities, individuals, and associations and firms of various kinds, are splendidly active and progressive. What they do need is a greater membership, and we hope that this conference is going to assist them to achieve this. For one thing we are going to appeal to all the local authorities in Scotland that are not yet members to come in and help us—to share with their fellow-authorities, who are members, the task of restoring clean air to all Scotland.

The Economics of Smoke

It is particularly fitting that we should be holding our annual conference at this moment. The question of economy is in all our minds and not least that of His Majesty's Government.

Amongst those economies the most vital and pressing is the saving of every ounce of coal. I say without fear of contradiction that had the advice of this Society over the past 30 or 40 years regarding the efficient use of coal been taken we should to-day have no difficulty in earning foreign exchange by the

export of this commodity and of buying the raw materials and other things needed to maintain our badly flagging standard of life.

Our friends of the Fuel Research Station have shown us that each year some 2½ million tons of smoke in the form of unburned portions of the coal substance are poured into the atmosphere. They have also shown that where there is a loss of heat in the form of visible smoke there is also a much greater loss—in some cases up to 10 per cent.—in the form of invisible gases that could also have been burned. Altogether, therefore, in the smoking chimneys of homes and factories of this country there is a total loss of heat to the nation each year equal to about 10 million tons of coal.

What a magnificent present this would be to give to our country at this time! What much-needed food and raw materials we could exchange for it with other countries if only we had it in the holds of our ships instead of polluting our atmosphere and causing untold damage! It is true that the winds of heaven do, in time, disperse some of it and export it for us across the seas—but then it is an export no one wants, and for which no one will pay. What a fantastic waste this is!

Waste in any field of economic activity is something we can no longer afford, and to prevent waste is as valuable as increasing production in other ways—it is in fact more valuable, for it increases production without using up more materials or manpower. But waste in the form of smoke is waste of a higher degree than waste in general—it is a cumulative waste that creates another waste.

The defensive measures we are forced to take against smoke—the cleaning, repairing, renewing, painting and washing of material things; the restoring of health and vitality; the compensations for the loss of amenity, and so on—all these are waste because they absorb the labours, wholly or in part, of an immense number of people, and so deprive us of the fruits of that labour in creating the new wealth we so urgently need.

If the whole nation in the past had hated smoke as much as a few of us have hated it, so that by now it had been ended and forgotten, we should be richer and in many ways better able to cope with our problems.

The high responsibility of this Society, and its contribution to our national economic recovery is to see that the reforms we demand are put into train and achieved as quickly as possible. Smoke abolition is not one of those pleasant luxuries that have to wait until we have reached the land of plenty; on the contrary it is one of the fleet of vehicles provided by science and technology that can take us there.

A Lesson from Pittsburgh

The first day of our conference is, curiously enough, a day of importance to smoke abatement in the United States of America, particularly to the once notorious but now greatly reformed, City of Pittsburgh.

The City adopted a sweeping new smoke prevention ordinance in 1941, under which all industrial and other establishments must either burn smokeless fuel or use a mechanical furnace, stoker or other device approved by the Bureau of Smoke Prevention. Except in the case of domestic appliances, annual inspections of plant—for which a fee is charged—are made, and certificates of operation are granted. All new installations must be previously approved by the Bureau, and what it is particularly important to note is that all coal-dealers working in the city must take out a licence. It is illegal for them to deliver high volatile coal except to establishments having approved anti-smoke equipment.

Because of the war, these provisions were not put fully into operation, but to-day, 1st October, 1947, the provisions of the ordinance are extended to all chimneys and establishments, *including all private dwelling houses*.

Pittsburgh thus follows the pioneer example of St. Louis, and we in this country, who are advocating similar far-reaching methods for abolishing smoke, will look forward to hearing further news of progress.

What is the moral of this? Our American friends, or some of them, suffer from smoke as much as we do, and they have in the past, regarded this country as setting a fine example in smoke prevention administration, in the scientific study of the problem, and in our Society's work of education and propaganda.

But they now seem to be getting well ahead of us in the effective control of air pollution, as this example of Pittsburgh shows. The principles they are using—especially prior approval and the licensing of the use of bituminous coal—are what we, too, are asking for. Smoke, as I have stressed, is largely an economic

waste, and clearly it is one that it will profit us to try to eliminate at least as resolutely as our American friends, who, though they could afford it better than we can, seem to hate waste more than we do. Perhaps indeed, that is one of the reasons why they could better afford it.

We, know too, how much the Americans prize individual freedom—and yet we find them accepting drastic permanent controls and restrictions on the buying and selling and use of fuel that we in this country are still debating. But there is no inconsistency—they have rightly recognized that the freedom to buy what fuel they like and to burn it how they like must be subordinated to the more important freedom to live in and breathe a pure and healthy atmosphere.

Conclusion

At our conference a year ago, I was reproached by an old friend for being too optimistic about the progress of our movement. Although I still believe that thanks to the National Smoke Abatement Society we have been brought within sight of the promised land, I might have spoken with less confidence had I foreseen the setbacks and frustrations of the past year. The breakdown in fuel and power supplies and the continued shortage of manpower and materials has postponed the progress which we had hoped to achieve. We still await an adequate supply of smokeless fuels, and domestic appliances are still in short supply. In addition the low quality of coal delivered to all types of customers is increasing the cloud of soot that blankets our cities.

Dare we hope that these obstacles will be overcome before it is too late to ensure smokeless equipment throughout our delayed housing schemes? Again are we planning for a more general adoption of smokeless methods and systems for the housing estates in course of development, and in all the new industrial areas? To make sure that less efficient, more smoky methods are rejected or prohibited, and that foresight is exercised to ensure that only the most efficient are used, is one of our Society's growing concerns. How we wish we had the resources to do all the work we ought to be doing in guiding, encouraging and assisting in this great and urgent task of raising the standards at which fuel is used, wherever it is used.

Those of us concerned with health and social movements must have been impressed by the greatly increased attendance at such conferences as this. Some critics have suggested that they have become merely holidays for delegates, but the attentive audiences and the instructive discussions give convincing proof that these occasions serve a valuable educational purpose. But there is some doubt whether delegates pass on the knowledge they acquire to the Local Authorities they represent. It seems most desirable that they should report a summary of the proceedings for the benefit of their colleagues. This Society would also like smoke abatement to be the King Charles's Head to be mentioned on every appropriate occasion at meetings of councils and committees.

Above all, you delegates can help our movement by persuading local authorities and others to become subscribing members of our Society. The pioneer work done by the Society, the services it offers as a clearing house for all information bearing on smoke abatement, the publication of its excellent official journal—all these activities justify us in expecting the support of enlightened organizations and individuals who recognize the health and economic importance of Clean Air.

Area Organization for Smoke Prevention

The Scottish Division

By ALLAN W. RITCHIE, M.B.E., F.R.San.I.
President, Scottish Division

IN view of the Annual Conference being held in Edinburgh this year, the history of the Scottish Division should prove of special interest.

The first recorded meeting of the Glasgow and West of Scotland Branch of the Smoke Abatement League of Great Britain (which succeeded the Glasgow and West of Scotland Smoke Abatement Association) was held in the City Chambers, Glasgow, on 16th February, 1910. At that meeting a Constitution and Byelaws were adopted. The first acting President was Councillor William B. Smith, Glasgow, and the Honorary Secretary was Peter Fyfe, Sanitary Inspector, Glasgow.

These pioneers set to work early and earnestly to publicise the Society and its activities ; this is evidenced by a decision on 15th March, 1910, to hold a series of nine lectures to be delivered in different areas by eminent speakers on such subjects as " The City Atmosphere and the City Health " ; " The Chemistry of Combustion " ; " How to Fire Steam Boilers Smokelessly " and " The Necessity for Pure Air." At the same meeting, the Secretary intimated that there were ninety-seven members who had duly paid their annual subscription. It is not clear whether there were others who had not subscribed. Life membership for payment of £1 10s. was introduced.

At this stage, lectures on combustion to firemen were inaugurated and School Boards and firms were circularized. A fee of 5s. per student was charged.

At this time the total funds of the League amounted to £64 12s. 9½d., which included £14 12s. 9½d. taken over from the Glasgow and West of Scotland Smoke Abatement Association. The membership in June, 1910, was 208.

The Smoke Inspectors on the staff of the Sanitary Departments, Glasgow and Edinburgh, were the tutors in the Firemen's Classes which were held in these cities. It is interesting to note that even at this early stage the civic authorities were anxious to further the success of the Society and that this assistance has been given till the present day.

The first Conference of the League was held on 28th September, 1910. The first Annual Report of the Society was issued in March, 1911, and showed that there were 225 members of whom 3 were life members ; 8 lectures for the public had been delivered, 60 lectures for firemen, 180 firemen had enrolled and 137 had had full attendance.

Early Progress

A report of an address by Mr. George Ness, Chief Engineer of the Scottish Boiler Insurance Company in the *Glasgow Herald*, dated 8th June, 1912, bears testimony to the fact that the efforts of the League were being rewarded. Mr. Ness referred to the improvement which had taken place during the last two years in the atmosphere of the City. While much of that improvement had been traceable to the beautiful summer of the previous year and to the indications of another excellent season, actual facts showed that there had been a decided improvement both in regard to domestic and factory smoke. From his own knowledge as one in close touch with power producers, he found a decided trend in favour of an improvement of the conditions under which their power was produced. Out of a large number of chimneys under observation, a number of years ago, 46½ per cent. were now clear of smoke, while 22½ per cent. gave only a small amount of smoke not reaching the line of excess by any means. There were 27½ per cent. which were intermittent smokers, and there were practically none which now gave excess smoke. This was proved by the fact

that the convictions that year were 50 per cent. less than the previous year so ar as chimneys were concerned, so that there were evidences of real improvement. Of the steam boilers which were formerly employed to produce power in the City, practically 10 per cent. had had their power increased, and by that increase the smoke had been reduced. Thirteen per cent. had added mechanical stokers with a view to the reduction, not only of smoke, but of waste in producing power, while eighteen per cent. had been fitted with smoke prevention apparatus. When they came to plants used for manufacturing purposes they found that thirty-three per cent. of those formerly fired by coal were now fired by gas, resulting in a very great reduction of smoke.

A special meeting of the League was held in October, 1912, to consider the advisability of a crusade in the central business area of Glasgow against smoke issues from domestic and office fires. It was agreed that a general meeting of the Citizens should be convened by the Lord Provost to discuss smoke abatement, and that in the first instance the Lord Provost be asked to receive a deputation consisting of representatives of the Chamber of Commerce, the Faculty of Physicians and Surgeons, the Merchants' House, the Trades House, the Glasgow Shopkeepers' Associations, the Faculty of Procurators, the Landlords' and House Owners' Association, the House Factors' Association, and other public bodies.

On 17th April, 1914, the Smoke Abatement Bill was submitted to the Council and consideration thereof was continued.

Meetings of the Branch were not held during the years 1916 to 1919. The first meeting after the first World War was held on 31st May, 1920, when Mr. Peter Fyfe, the Honorary Secretary, intimated his resignation consequent on his appointment as Director of Housing in Glasgow. Since that time the Society has been specially well-served by members of the Town Clerk's Department who have acted as Secretary.

The Scottish Branch

It was on 9th March, 1927, that the Scottish Branch of the Smoke Abatement League of Great Britain was formed, and meetings were held in different places. An executive Committee was appointed consisting of one representative from each local authority and other bodies represented at the Conference held on said date.

At a meeting on 23rd September, 1927, the attention of the Branch was directed to the Public Health (Smoke Abatement) Act 1926, which applied to England only, and it was agreed that representations be made to the Secretary of State for Scotland to have a similar Bill introduced for Scotland, and to have included extended powers to Police Authorities to prevent the emission of smoke or steam from vehicles on streets. At this meeting also a representative from the Scottish Council of Women Citizens' Associations was appointed to the Executive Council.

On 2nd May, 1928, the Branch became affiliated to the Association for the Preservation of Rural Scotland.

On 11th December, 1929, it was agreed that the League should be amalgamated with the Coal Smoke Abatement Society of London and become known as the National Smoke Abatement Society.

On 15th October, 1930, due to the delay in introducing a Smoke Abatement Bill with provisions similar to the English Act, it was agreed that further representations be made to the Secretary of State and that local authorities be urged to support the Society.

In 1932 it was agreed, with a view to having the certificate issued to firemen attending the classes recognized, that local authorities and firms be requested, when making appointments of firemen or stokers, to give priority to applicants holding a certificate issued by the Society.

Fumes From Vehicles

During this time smoke from vehicles on streets had been engaging the attention of the Society and it was agreed that representations be made to the Ministry of Transport to have Regulation No. 18 of the S. R. & O., 1931 amended to read: "Every motor vehicle using solid fuel shall use only smokeless or non-bituminous fuel and shall be fitted with an efficient appliance for the purpose of preventing the emission of sparks or grit, and also with a tray or shield to prevent ashes and cinders from falling on the road."

At the request of the Secretary of the Committee on Scottish Health Services appointed by the Secretary of State to review the health services and make recommendations on changes in policy that may be necessary for efficiency and economy, members were appointed to submit evidence on "smoke abatement."

At a Conference in 1937 a vigorous protest was lodged with the Scottish Development Council against a statement in a report of the "Oil from Coal

Committee" which disapproved of encouragement being given to processes which produced a free-burning solid smokeless fuel because such fuel would compete with the sale of raw coal. The Society also asked that a supplementary report be issued by the Council referring to the production of solid smokeless fuel and the beneficial effects arising therefrom.

The Special Areas

In the same year a deputation was appointed to make representations to the Commissioner for Special Areas to impress on him the necessity and desirability of installing plant at a Scottish Colliery for the production of a suitable smokeless fuel. The Commissioner assured the deputation that any application for assistance in the establishment of smokeless fuel plant in a depressed area would receive his sympathetic consideration. Thereafter the Secretary communicated with the manufacturers of "Suncole" and "Coalite" and other companies willing to produce smokeless fuel with a view to the establishment of plant in Lanarkshire or other special area in Scotland for the production of smokeless fuel. At least one manufacturer contacted the Commissioner.

Reverting to the classes for firemen, in 1943 the Ministry of Fuel and Power asked if they could join with the Scottish Branch in the promotion of classes for firemen and boiler operatives, and the request was granted.

The Scottish Housing Advisory Committee were asked in 1944 to give the Branch an opportunity of submitting suggestions regarding the heating of post-war houses in relation to the problem of atmospheric pollution. The B.B.C. were asked to include in their Scottish News Summary, items of interest relating to smoke abatement and/or to give an opportunity for talks on Atmospheric Pollution by prominent members of the Branch or other speakers. It was also agreed that efforts be made for the showing in cinemas throughout the country, of a short flash of a non-technical nature, stressing the great advantage of atmospheric purity.

The New Constitution

The new Constitution of the National Smoke Abatement Society was adopted in August, 1945 by the Scottish Branch, subject to certain reservations. The principal effects of the Constitution were, (a) to provide for an increase in the amount of subscriptions all of which in future would be paid to the Society, and (b) to divide the Society into eight geographical divisions, of which Scotland would be one, each division to be administered by a Divisional Council whose activities would be subject to the general approval and guidance of the Executive Council of the Society, which would make grants to the Divisions for approved expenses. The reservation above referred to, concerned finance.

The representatives of the Scottish Division on the Executive Council of the National Society are Councillor Munro, Bailie Mrs. Lappin and myself.

In order to stimulate interest in the movement the Scottish Division has held Conferences in various parts of the country. This year's Conference was held in Falkirk, and was combined with an exhibition of modern fuel appliances.

As has been the experience in other parts of the country, it has proved somewhat difficult to arouse an interest in smoke abatement, but it is undeniable that very real progress has been effected particularly in the larger industrial areas as a result of which many factory owners have introduced plant capable of giving the maximum amount of heat from the minimum amount of fuel. There has also been a remarkable development in the use of gas, electricity and solid smokeless fuels in domestic heating.

The coal crisis experience of the post-war years has also helped to bring home to the whole community the need for preventing waste of fuel caused by the discharge of smoke into the atmosphere.

The North-West Division

By H. MOORE, *Honorary Secretary*

THE first meeting of the Division under the new constitution of the Society was held in the Town Hall, Manchester, on the 18th July, 1946. The Lord Mayor (Councillor Hugh Lee) opened the meeting, expressed his keen interest in smoke abatement, and wished the Society every success in its efforts to secure a smoke-free atmosphere.

A Divisional Council was elected which has met on four occasions during the year—at Bolton, Liverpool, Man-

chester and Widnes, conforming to the desire of the Council to meet at various centres within the Division. Despite the prevailing difficulties of general shortage of man-power and materials, accentuated by the winter fuel crisis, the Divisional Council have made appreciable progress.

At the second meeting of the Council, a small Committee was appointed to consider activities and policy. Under the Chairmanship of Professor Tylecote, this Committee approached the National Executive Council with regard to fundamental principles in smoke abatement with reference to the manufacture of smokeless grates, supplies of solid fuels, installation of smokeless appliances in new houses, subsidies to encourage replacement of obsolete pattern grates, smokeless zones, district heating and investigations into the practicability of reducing costs of electricity and gas.

A display of films on smoke abatement and town planning was arranged with the aid of the Central Office of Information and the Manchester Gas Department. The exhibition of the films to the Divisional Council and representatives of many Local Authorities in the area, though interesting, revealed the need for an up-to-date smoke abatement film. It is hoped that the new film to be produced by the British Gas Council, and in which the Society's co-operation has been asked, will have strong reference to smoke abatement.

The Council realise the many difficulties which prevail at the present time, notably the fuel shortage, and the inadequacy of production of the modern smokeless grates and appliances. They do not accept the view that these difficulties are insurmountable; on the contrary, the Government are being urged to take advantages of all opportunities to implement the recommendations of the Simon report on Domestic Fuel Policy. The fuel crisis serves to emphasize the importance of avoiding waste in the use of raw coal and should act as a spur to the Government to combine economy of fuel with smoke abatement and to give this matter high priority in National policy.

More recently, the Council directed representations to be made to the Minister of Fuel and Power, urging that action should be taken to increase the production of smokeless grates, to popularize the new appliances by widespread publicity, to encourage Local Authorities to instal them in all houses in their areas and to ensure that adequate supplies of solid smokeless fuels are available. The Council will continue this campaign to call for positive action at every opportunity, and trust that Divisional Councils in other areas will join forces with them, so that the demand for smokeless air will be truly national.

The Council has continued to co-operate with the Institute of Fuel in holding two successful joint meetings in Liverpool and Manchester. Both meetings were well attended and there was undoubted evidence of a growing interest in the smoke problem which is encouraging. A further joint meeting has been arranged to take place in Manchester on 14th January, 1948, when the subject will be "District Heating."

Yorkshire Division

By JAMES GOODFELLOW, *Honorary Secretary*

FURTHER progress has been made in regard to the formation of a Yorkshire Divisional Council.

At the meeting of the Yorkshire members and representatives held in Leeds on the 20th June, the proposal of Mr. John W. Beaumont, Vice-Chairman of the Society's National Executive, that a Divisional Council for Yorkshire be set up, was carried unanimously. While it was stressed that this new committee would in no way duplicate the work of the West Riding Regional Smoke Abatement Committee, it was agreed that only a broadly based committee could coordinate the interests of all individuals, authorities, technicians, and industrialists, concerned with the smoke menace.

The following members were elected to serve on a provisional committee charged with the drafting of a constitution for the Divisional Council:

Mr. E. J. Winfield, of Castleford; Mr. J. W. Beaumont, of Halifax; Councillor Mrs. Dell, of Pudsey; Councillor Roberts, of Rothwell; Capt. A. W. Brown, M.B.E., J.P., of the British Electrical Development Association; Mr. A. C. Saword, of Hull; Dr. J. Johnstone Jervis, of Leeds; Mr. T. Henry Turner, of Doncaster; and a representative of

the Bradford Civic Society.

This provisional committee met on the 22nd July at the Public Health Department, Vicar Lane, Leeds, under the chairmanship of Mr. A. C. Saword. Rules and Constitution for the Yorkshire Divisional Committee were drawn up, and are to be submitted to a General Meeting of the Yorkshire members to be held in Leeds on the 18th September. It can therefore be anticipated that this new offspring will have begun a lusty infant existence by the time of the Edinburgh Conference.

The Regional Smoke Abatement Committee

REPORT BY THE SOCIETY

THIS discussion on area organization for smoke abatement would, of course, be incomplete if it did not consider the important position of the Regional Committees. To have asked each of the seven to present an individual report would, however, have over-lengthened our programme today, and the account that follows is a composite report based on the replies kindly supplied by the Committees to questions put by the Society.

The Regional Committees are joint committees of local authorities, all but one of which are of an advisory character only, not based on, nor able to apply, any statutory provisions. The one exception is the Sheffield, Rotherham and District Committee, in which the constituent authorities have combined for the carrying out of their responsibilities under the smoke abatement sections of the Public Health Act, 1936. The active Advisory Committees number six, with a seventh, that for Northumberland and Durham, not yet re-established after suspending its work in 1939. The others, too, suffered for a time, because of wartime conditions, but are now all reconstituted and working. The essential facts about the membership and incomes of the Committees, including the Statutory Committee, are given in the accompanying table.

From this it will be seen that the committees have an aggregate membership of 278 local authorities, and that, excluding the statutory committee, their combined income is £425. The Statutory Committee has its own staff of smoke inspectors, and is in an entirely different financial category.

Present Activities

The replies received show that each of the Committees is actively concerned with what one of them sums up as being "a co-ordinating body towards the education of local authorities for smoke abatement." Co-ordination, discussion of mutual problems, advice and assistance to members and others, are indeed the main functions of the Committees. Developments in propaganda, educational work, the training of fireman and similar activities are mentioned. The Manchester and West Riding Committees also mention that they are giving assistance to their constituent authorities in relation to new housing and the implementation of the recommendations for the more efficient use of fuel in the home, made by the Fuel and Power Advisory Council in the Simon Report. The West Lancashire and Cheshire Committee has issued a memorandum on domestic heating to its constituent authorities, and is hoping to arrange for a permanent exhibition of solid fuel appliances in Liverpool.

Projected Activities

Replies to a question on this show that an extension and intensification of present work is generally desired, and that there are many other activities waiting to be developed. These include lectures and exhibitions (Bristol), liaison with the Regional Planning Authority (Manchester), co-ordination between the local authority members and other national and regional organizations e.g., the D.S.I.R., the Ministry of Fuel and Power, the N.S.A.S. (Midlands), attention to the railway smoke problem (Manchester), visits to works and installations (West Lancashire and Cheshire), the instruction of works' engineers and operators, and advice to manufacturers on new and reconstructed plant (Sheffield), and inquiries into district heating and other projects. Altogether it can be seen that there is a very considerable amount of important work waiting to be done.

THE REGIONAL SMOKE ABATEMENT COMMITTEES

	Number of Constituent Authorities	*Number of non-member Authorities in area*	*Subscription Rate*	*Annual Income*	*Hon. Secretary*	*Address*
Bristol & District Regional Smoke Abatement Committee	18	8	£2 2s. Boroughs and large U.D.C.s £1 1s. U.D.C.s under 10,000 pop. 10s. 6d. R.D.C.s	£14	Mr. F. J. Redstone, F.R.SAN.I., F.S.I.A., Chief Sanitary Inspector	Public Health Department, 48, Queen Square, Bristol, 1.
Greater London Advisory Council for Smoke Abatement	64	33	£4 4s. London C.C. £3 3s. other C.C.s £2 2s. all others	£140	Mr. Clifford Ratcliff	31, Charing Cross Road, London, W.C. 2.
Manchester & District Regional Smoke Abatement Committee	79	27	£2 2s.	£170	Dr. C. Metcalfe Brown, M.D., D.P.H. Medical Officer of Health	Town Hall, Manchester, 2.
Midlands Joint Advisory Council for the Abatement of Smoke and Atmospheric Pollution	48	58	£1 1s.	£50	Dr. W. R. Martine, O.B.E., T.D., M.D., D.P.H.	c/o Public Health Department, Council House, Birmingham, 3.
Sheffield, Rotherham and District Smoke Abatement Committee	5	3	Proportionate to rateable value	£3,000	Town Clerk, Sheffield (Chief Inspector : Mr. James Law,)	Town Hall, Sheffield.
West Lancashire and Cheshire Regional Smoke Abatement Committee	17	10	£2 2s. Boroughs £1 1s. U.D.C.s	£28	Dr. W. M. Frazer, O.B.E., M.D., M.SC., D.P.H. Medical Officer of Health	Gordon House, Belmont Grove, Liverpool, 6.
West Riding of Yorkshire Regional Smoke Abatement Committee	47	nil	10s. or according to expenditure	£23	Dr. J. Johnstone Jervis, M.D., D.P.H.	Public Health Department, 12, Market Buildings, Vicar Lane, Leeds, 1.

Development into Statutory Committees

As stated, the Committee for Sheffield, Rotherham and District is the only one having statutory powers. Its experience has shown that such joint action is fully practicable, while the Committee themselves are quite satisfied that this is the most rational and economic method of controlling smoke emission.

The question of whether they should transform themselves into similar bodies has been considered by some of the Advisory Committees. Manchester, for instance, is in agreement that such a form of administration is desirable in many respects, and would in fact probably have established such a committee in 1939, but for the outbreak of war. The project has recently been considered again, and it has been agreed to defer further inquiry until it can be seen what changes in local government, including municipal boundaries, are to take place in the near future. Bristol, West Lancashire, and Greater London have not yet considered the matter, and in Yorkshire and the Midlands it has been considered and not favourably received. The Midlands also advise deferment of further consideration until local government reorganization has been effected.

Functions of the Committees under New Legislation

The Committees were set up to work within the framework of the smoke abatement legislation that has remained substantially the same since 1875—control based on observations of smoke emission by an officer of a local authority or combined local authorities. There are now proposals being developed and discussed for new forms of legislation controlling smoke emission through the prior approval of new fuel-burning installations, the setting up of smokeless zones, and the licensing of bituminous coal for use under approved conditions only. These are radical developments, and they will require considerable changes in administration. The question arises whether such changes will affect the Advisory Committees and call for a new examination of their functions and the question of administering the new legislation through regional units.

This was admittedly a difficult question, at the present stage, to put to the Committees, but the replies show that it is already appreciated by some, even though it has not yet been considered by others. There is again a feeling that it must be deferred until the local government position is clarified, and it can be examined in conjunction with the general question of joint statutory action under the existing law. At the moment the value of asking the question is perhaps mainly in stressing the fact that if we are to ask for the basis of smoke prevention to be revolutionized, we must be able to show how the new order is to be administered, and in this, the Regional Committees will naturally have an important voice.

The Committees and the Society

Finally, we asked the Committees if there was any confusion among their local authority members and potential members about their nature and functions in relation to those of the Society. Many local authorities are, of course, members of both the Society and their appropriate regional committee, and some are now also actively associated with the Divisional Councils of the Society. The set-up is admittedly rather confusing at first sight, and it is reassuring to note that the Committees consider either that no serious misunderstandings now exist, or that they can easily be removed if and when they do arise.

What difficulties there are, it is said, might be increased by the formation of the Society's Divisional Councils, although this is not expressed by the Committees in the areas where the latter have so far been formed.

The main material point, is, of course, in the membership of local authorities of two related organisations, and it must be emphasized again that the Committees consist solely of local authorities, and as such, have a special function to perform. The Society, on the other hand, includes and provides a meeting ground for local authorities and all others interested in the smoke problem. It seems to be quite fair to suggest that the two suscriptions payable by a local authority should be regarded as two parts of a single contribution—and a very modest one at that—to smoke abatement on district and national levels. Since the Committees and the Society work so closely together, and each in many ways helps the progress of the other, it is clear that the real value of support given to the one is enhanced when the other is also supported.

One Committee sums up its view by pointing out that some members of its

Executive are also members of the Society's national or divisional Councils, " and this arrangement might be pursued by other Regional Committees to secure a closer liaison at the highest level between the two organizations." Further: " with the opportunities which they have through their member local authorities, the Regional Committees might assist in persuading authorities to join the National Smoke Abatement Society, and in further publicizing the Society's literature and publications."

In conclusion, the thanks of the Society must be expressed to the Regional Committees and their Hon. Secretaries for the information contained in this report and supplied by them at short notice. This in itself is an excellent example of the spirit of cordial and helpful co-operation that exists between the Committees and the Society, and is a good augury for progress in the common tasks that lie ahead.

Discussion

MR. JAMES LAW (Sheffield, Rotherham and District Committee) said that as the Chief Inspector for the only Statutory Regional Committee which had been functioning for the past 17 years, he was pleased to have the privilege of giving his experiences with regard to this work, and of the feeling of frustration and disappointment at the lack of progress in other areas. When the Committee was formed in 1930, it was stated that " steel could not be fabricated without making smoke." It took six years of research to prove that " providing suitable appliances were used, smoke was not necessary." Then, trade was too poor to justify expenditure. Later, the excuse was "that re-armament must not be impeded," and again " we were in a state of emergency." The war came and they were told " to make as much smoke as possible without causing too much waste." Fuel became scarce, but they were asked " not to stop smoke " without consulting the Ministry about it. Now, it was the poor quality of the fuel that was impeding progress and the inability to obtain suitable supplies. The time was never opportune and the " merry-go-round " of evasion continued. The industrial gas demand had increased from 9 million cubic feet per day to 50 million cubic feet, and for the time being that was the end of their resources. About one half of the boiler plants were mechanically operated and one third of the coal fired process furnaces.

Prior approval for industrial leasing clauses was commenced in May, 1946, and it had been extended to Regional Planning for light and heavy industries. During that period, over 300 prospective heating plants had been approved and opposition had only been offered in five cases which, he thought all would agree, showed a spirit of co-operation that was going to have far-reaching effects in the future. Their area was not clean but they were progressing slowly and their difficulties were one by one being overcome.

He wondered if other Regional Committees could say the same thing. When he looked at the list of Regional committees on an earlier page, he began to wonder if people were serious with regard to smoke abatement or not. With the exception of the Sheffield Committee there were 278 authorities with a total income of £425 per annum, or 27s. 4d. per authority. In other words, the confidence placed in smoke abatement was that, for the sum of 27s. 4d. per annum, you could keep your district and your conscience clean. How much work could a committee do with an income of £14. In order to know what was taking place in any area, continuous observations and visits to works were necessary. Who was doing this observation work, and what right of access had any members of Advisory Committees? Even supposing this part of the work was done and continued nuisance was reported, how did these Committees proceed?

These, said Mr. Law, were the fundamentals of smoke abatement work and if they were not being carried out, the Committee might just as well cease to function.

The Society were somewhat concerned with regard to Regional Committees and their attitude toward Divisional Councils. It would be interesting to hear the views of other Committees, but so far as Sheffield was concerned these Councils would perhaps give them a better understanding of each other's point of

view and of difficulties which had to be met and overcome. If it would stimulate the desire for a cleaner atmosphere and for definite action, instead of much of the talk without action that was taking place, Divisional Councils would serve a useful purpose.

Dr. W. R. Martine (Birmingham) said that he could not allow Mr. Law's remarks to pass unchallenged, but before he counter-attacked he would like to congratulate Mr. Moore on the strong line he had taken in asking for a real lead in smoke abatment from the powers that be. He, Dr. Martine, was convinced that the production of appropriate appliances and of smokeless fuels would have to be on a footing comparable to the recent war effort, if effective results were to be obtained, and for that the lead must come from the top.

Mr. Law might have a different problem in Sheffield from that of the Midlands—the gloom of his district certainly would support that view. He continued to accuse the Midland Regional Advisory Council of being extinct; on this occasion basing such an opinion on stated income. It was not, however, just a case of filthy lucre. Larger membership would be welcomed, of course, but all the large authorities did subscribe and funds were adequate. The view was still held in the West Midlands that a Regional body could help local authority and individual offender alike more effectively in an advisory than in a statutory capacity, and that if local authorities were using all the powers available through the Public Health Acts—which in fact all were not—and still further powers were required, such additional powers should be vested in the local authority and not in a composite regional body.

Alderman J. J. Milton (Bristol), said he had risen to speak as he represented the Bristol and District Regional Committee, whom the last speaker mentioned as having an annual income of only £14 a year. Money was not always a measurement of work done. It was not in their region. They had, prior to the war, made considerable progress towards improving fuel efficiency and the abatement of smoke pollution. They had convinced industrial concerns of the waste and ill-effects of smoke and grit emission. They had joined with the local smoke abatement committee in persuading the Merchant Venturers Technical College to run classes for stokers and to arrange for stokers, boilermen and firemen to have time off to attend the classes. They persuaded them and the Local Authority's Planning and Works Committee that when alteration to plant or new installations were contemplated they would jointly consult with the Regional Committee on the best type of plant to install, bearing in mind fuel efficiency and the smoke and grit problem. It was considered best to confer while work was in progress rather than wait and complain later. The war interfered with this work and they were getting many complaints due largely to poor types of fuel and inefficient plant. They found that, in the main, managements were sympathetic and helpful.

Alderman Milton then spoke about the Bristol Electric Power Station situated at Portishead, outside Bristol. The District Council brought a complaint of smoke and grit emissions to the Regional Council and the Chairman and Secretary of the Regional Council saw the Town Clerk of Bristol, together with the Engineer and Manager of the Electricity undertaking. The Power Station was at present being enlarged, and as a result of the Regional Council's efforts, grit arrestors and smoke washing plant were to be installed. They had been assured that when the work was completed there would no longer be grounds for complaint.

In the commercial centre of the city of Bristol a scheme of smokeless heating and hot water installation had been accepted by the City Council and when labour and material were obtainable they were hopeful of setting up a Smokeless Zone.

In the domestic fire position they had the complete and positive sympathy of the Housing Committee who were installing as many of the new type of grate as they could get and had given a promise to the Regional Smoke Abatement Committee that they would, if the new type proved a success, remove the old type and replace them with the new ones when they were available.

Alderman Milton concluded by saying that when consideration was given to the break during the war years and all that it meant in the negation of their achievements they felt hopeful that they would slowly make headway again until their goal of a smokeless city was obtained.

Councillor Mrs. M. Dale (Wolverhampton), said that she did not know of

a more important question to women; men were in a majority at the conference, and she wished that women had been in that position. What was more important than health, clean air and less coal dirt to women-folk? There was a saying, "Tell a woman anything and the whole world will soon know." She asked why were women not being educated in smoke abatement, and suggested that there should be a women's section of the Society. Public opinion was wanted to achieve the object.

W. L. Mather (Mather & Platt, Ltd.), said that as smoke pollution was not confined within municipal boundaries it was hard to see how any scheme of prevention, based purely on municipal regulations and byelaws, could be effective since there was always likely to be some offender who stood out. He therefore considered that if such regulations were introduced they should be on a national basis. Mr. Mather went on to say that while he was impressed by the Simon report, he was most distressed at the target of 20 years which was given for the fulfilment of smoke abatement. It made him think that the existing arrangements were inadequate and that something more was required than was at present being done. Smoke was preventable, and had been prevented in all other countries except this, and until it was made illegal, he could see no hope of achieving it quickly. Regulations should therefore be introduced which, in the first instance, should consist of a British Standard Specification for fuel burning appliances, with which all new appliances would have to conform, and later some further regulations with a time limit which took care of the existing equipment that created a smoke nuisance.

Mrs. J. Falconer (Electrical Association for Women), said that the Smoke Abatement Society had already tried to "get at" women's organizations but the results had not been too successful. The Electrical Association for Women, for the past 21 years, had been doing its "darndest" to awaken interest in the smoke nuisance and get the coal fire abolished, but it was the man in the house who wanted a coal fire and would have nothing else.

F. J. Redstone (Bristol), said that it was not his intention to take part in the discussion on Wednesday morning, but that after some remarks that had been made he felt bound to make a few observations in defence—if that was the word necessary—of the work being carried out by the Bristol & District Regional Smoke Abatement Council. He could assure the delegates that this Council were making a full contribution in the move forward to a cleaner atmosphere, and from their record it was, in his opinion, clear that there was every reason for their existence and continued activities. This had been very evident from the appeals made by, and assistance already given to constituent members; in addition demonstrations of smokeless appliances—a competition for the best essay by young persons and a feature broadcast was being arranged for the near future. The small financial income to the Council had been referred to, but Mr. Redstone said that what they lacked in finance, the members of the Bristol and District made up for in enthusiasm. One further interesting feature was the link that had been made with Town Planning Authorities, and in Bristol industrial building leases were in future to include a suitable clause in connection with Smoke Prevention.

A great deal would be heard during the conference about grit nuisances, and he was pleased to say that Technical Officers of the Ministry of Fuel and Power were co-operating very fully in an effort to overcome nuisances of this character in the Bristol area.

W. Beaumont (Coventry), referred to the valuable contribution made by the Society in their efforts for the abatement of atmospheric pollution, local authorities had derived help and guidance particularly from recommendations made at the last conference held at Brighton. As a result of the reports of the Brighton Conference proceedings, his council was now considering securing powers for the creation of a smokeless zone, a scheme for district heating was contemplated, smokeless fuel burning appliances were being installed in all new council houses, and steps were being taken to secure "prior approval" in relation to all solid fuel burning appliances in industrial concerns.

The Work of Government Departments

Introductory Remarks by the Chairman

J. CAMERON SMAIL, O.B.E., F.R.S.E.

Principal, Heriot-Watt College, Edinburgh

I CONGRATULATE the organizers of the Conference on the variety and range of papers submitted. There is ample evidence that the disease of smoke is being carefully investigated and also the remedies. While it may not be entirely eliminated, at least it can be mitigated for the benefit of the community. Economic and industrial conditions, however, prevent the speedy application of some of the generally agreed and more obvious remedies, including improved plant and appliances. Considerable developments might, however, take place by more intelligent use of appliances now installed and by more careful supervision and attention to detail. The education of the various groups of persons interested, both in the supply and the use of various types of fuel, is being vigorously pursued from managers and engineers to housewives and stokers, but there is, in my view, the problem of obtaining sufficient numbers of skilled young scientists and engineers to tackle the large number of outstanding problems. I am glad to know that Mr. Edward will speak on what is being done in this direction and there is, no doubt, that a considerable amount of direct training has been given during the past few years with good results. The problem is, however, a continuing one and will call for attention in an increasing measure. Not only is smoke abatement desirable in itself, but fuel economy is now being pressed forward and has become a major issue in the country's welfare. This is readily understandable in view of the very great increase in the cost of coal and it does not appear that in the near future the cost will be materially reduced. Economy is therefore imperative, and it might be coupled with the elimination of the smoke nuisance.

The papers for submission and discussion by Mr. Hurley on "The Composition of Smoke" and the paper on "Atmospheric Pollution Research" by Dr. Meetham embody the results of very careful and extensive observations and these studies should have some significance for town planners who have had zoning as a major consideration for many years. The work of Government Departments in relation to smoke abatement, namely, the Department of Scientific and Industrial Research and the Ministry of Fuel and Power represent only a small part of the national activity devoted directly and indirectly to the matters under consideration. Other bodies having very special interest in the problems are the National Coal Board, the Meteorological Office, the Ministry of Supply and the Board of Trade—not to mention the Town and Country Planning Authorities, but the local government departments are most vitally interested and co-operation between them and the Government Departments will tend to solve some of the most urgent problems. "Auld Reekie" had its own problems but one of the diagrams in the paper before you will show that they might live in much less favoured areas.

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(1) Department of Scientific and Industrial Research

The Composition of Smoke

By T. F. HURLEY, O.B.E., B.Sc., A.M.I.C.E.,
Principal Scientific Officer, Fuel Research Station

Foreword

THE Fuel Research Station of the Department of Scientific and Industrial Research has worked for many years on the measurement and prevention of smoke from both industrial and domestic chimneys. In addition, as members of the Conference will be aware, the Department has for some years assumed responsibility for the work carried out in co-operation with local authorities and other interested bodies under the guidance of the Atmospheric Pollution Research Committee as described in the paper by Dr. A. R. Meetham.

The investigations dealing with the measurement of smoke emission have included the development of methods of measuring the density of the smoke, both as it passes up the chimney and as it leaves the chimney, and also the design of apparatus for collecting representative samples of smoke. The outcome of this work has included the correlation under various conditions of the concentration of the smoke with its optical density for both domestic and industrial chimneys.

Methods of preventing smoke have also been developed in connection with both domestic fireplaces and industrial boilers. On the domestic side the work has included the preparation of smokeless fuel in specially designed low-temperature carbonization plant and the design and testing of smoke consuming domestic fireplaces and appliances. On the industrial side the work has included the testing of full-scale grit arresters and the design of smoke eliminators for hand-fired boilers.

During the war, smoke eliminators developed at the Fuel Research Station were successfully applied to the majority of deep-sea coal-fired ships in the British and Allied Merchant Navies. These devices not only reduced smoke, but tests carried out under actual sea-going conditions showed that their operation resulted in an appreciable reduction in fuel consumption. The same principles are now being applied to devices suitable for natural draught Lancashire boilers for use on land.

As this session deals with "the work of Government Departments in relation to smoke prevention" it was originally intended to present a paper describing generally the investigations carried out at the Fuel Research Station relating to the measurement and prevention of smoke emission. It will be realized, however, that it would be impossible to cover adequately the whole of the work done by the Fuel Research Station in a paper of a length suitable for presentation at this Conference. Such a paper might be interesting and informative, but it would have much less practical value than one giving experimental data. It so happened an attempt was made to correlate certain aspects of the work of the Fuel Research Station on smoke reduction and smoke measurement in a paper presented this year to the Eleventh International Congress of Pure and Applied Chemistry. Only a short abstract of the paper was read at the Congress and the complete paper will not be printed in the proceedings of the Congress for a considerable time. As the information contained in the paper was felt to be of immediate interest to the National Smoke Abatement Society, permission was obtained from the Congress to present it in full at the present Conference, where it is thought it will be of far more practical value than the mere résumé which would be the result of trying to compress into one short paper the whole of the work of the Fuel Research Station on smoke prevention.

From the point of view of the National Smoke Abatement Society, perhaps the most important point made in the paper is that when smoke was made from a variety of coals in several different types of apparatus, varying in size from the domestic fire to the Marine boiler, the concentration of smoke in terms of the weight of suspended matter

per unit volume of flue gas was proportional to its optical density. In other words, optical density may be used as a measure of Atmospheric Pollution.

Members of the Society will be able to visualize so wide a field of application for this generalization, that it may be advisable to stress its limitations rather than its implications. Thus, in all the experimental work the intensity of the smoke was increased by restricting the air supply to the furnace and the results, therefore, apply only to smoke produced in this particular way. It is not to be expected for example that they will apply to grits or to light-coloured fine powdered fuel ash. Similarly, it must be remembered that the same weight of smoke will have a different optical density if th flue gases are diluted with air or with clear flue gases from another boiler.

Of scarcely less importance are the figures given for the combustible constituents of the smoke made under various conditions and for the magnitude of the corresponding waste of fuel. Many producers of excessive smoke know that even with really black smoke, the loss of potential heat in the visible smoke particles is relatively small, but they are not always aware how much more heat is lost in the associated invisible combustible gases. The data relative to these losses should be of considerable value in any campaign to show that making smoke does not pay.

Paper originally presented to the Eleventh International Congress of Pure and Applied Chemistry

Introduction

Most of the information already available concerning the solid, liquid, and gaseous products of incomplete combustion emitted from industrial and domestic chimneys has been collected during investigations into atmospheric pollution and refers to their general distribution in the atmosphere and over the surrounding countryside. Much less is known about the composition and concentration of the smoke as it passes up the chimney.

In the course of various investigations carried out at the Fuel Research Station over a period of years, a considerable amount of information has been accumulated which indicates that definite relationships exist between the optical density of the smoke and such factors as the concentration of suspended matter in the flue gases, the analyses of the suspended matter and of the flue gases, and boiler efficiency. These relationships are of interest from two points of view, firstly the extent to which the operation of furnaces under conditions giving rise to incomplete combustion effects atmospheric pollution generally and, secondly, the effect of such conditions upon thermal efficiency. Both aspects are of national importance as the first affects the health and general well-being of every individual living in or near industrial areas, while the second affects the amount of fuel required and therefore fuel costs.

Smoke of Constant Intensity

In a Technical Paper* recently published by the Fuel Reasearch Station, the results are given of a series of tests in which the extent to which smoke was emitted from the chimney of a hand-fired Lancashire boiler was controlled by deliberately restricting the quantity of secondary air admitted over the fire. Apparatus was installed by which the smoke passing up the chimney at any time could be given a " smoke number " proportional to its optical density, and arrangements were made for collecting representative samples of the suspended matter and of the flue gases. Tests were made over a wide range of smoke numbers with strongly and weakly coking coals at full load and at half load. The conditions were artificial to the extent that the smoke intensity was maintained constant during each test by frequent firing and in addition, the method of controlling the secondary air was not conducive to a high degree of turbulence in the furnace. The results obtained may, therefore, be closer to those which might be expected from some types of mechanically fired boiler than from a hand-fired boiler. Nevertheless the general trend of the relation between smoke and its composition may be capable of general application.

It was found that both at full load and at half load the total weight of suspended matter emitted in a given time was proportional to optical density, but with a given smoke number more was emitted in unit time at full load than at half load (Fig. 1). Optical density by itself, therefore, does not give a measure of the extent to which a certain chimney is responsible for atmospheric

* Department of Scientific and Industrial Research, Fuel Research Technical Paper No. 33—Smoke and its Measurement, H.M.S.O., 1946, Price 6d.

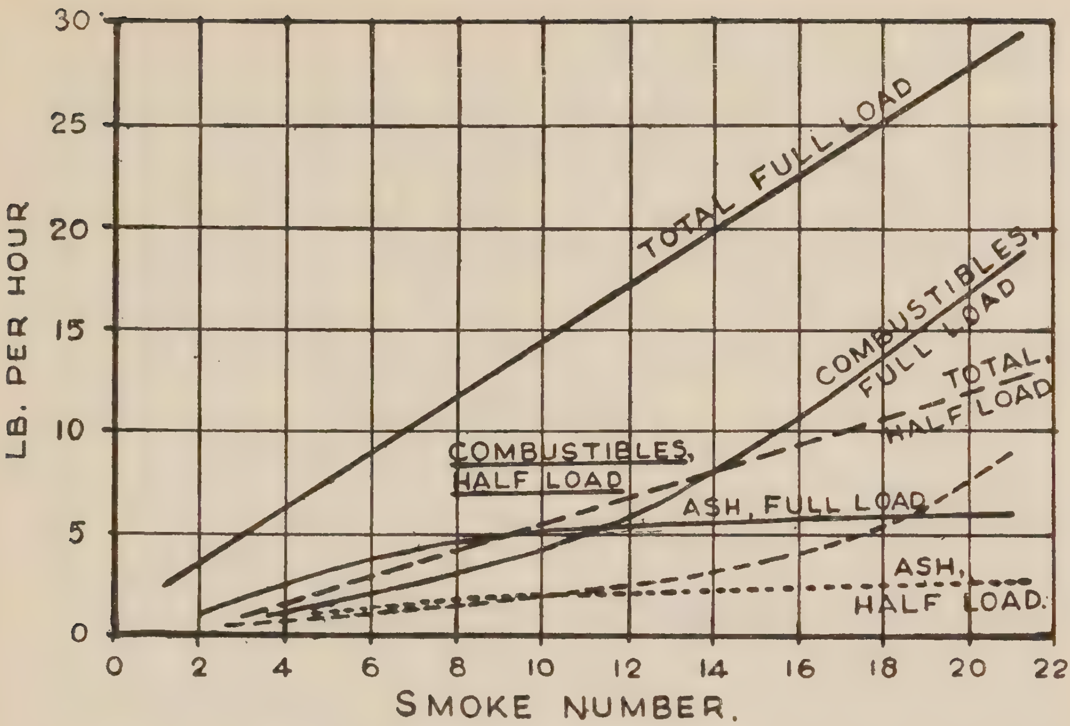


FIG. 1. RATE OF EMISSION OF SUSPENDED MATTER—LB. PER HOUR.

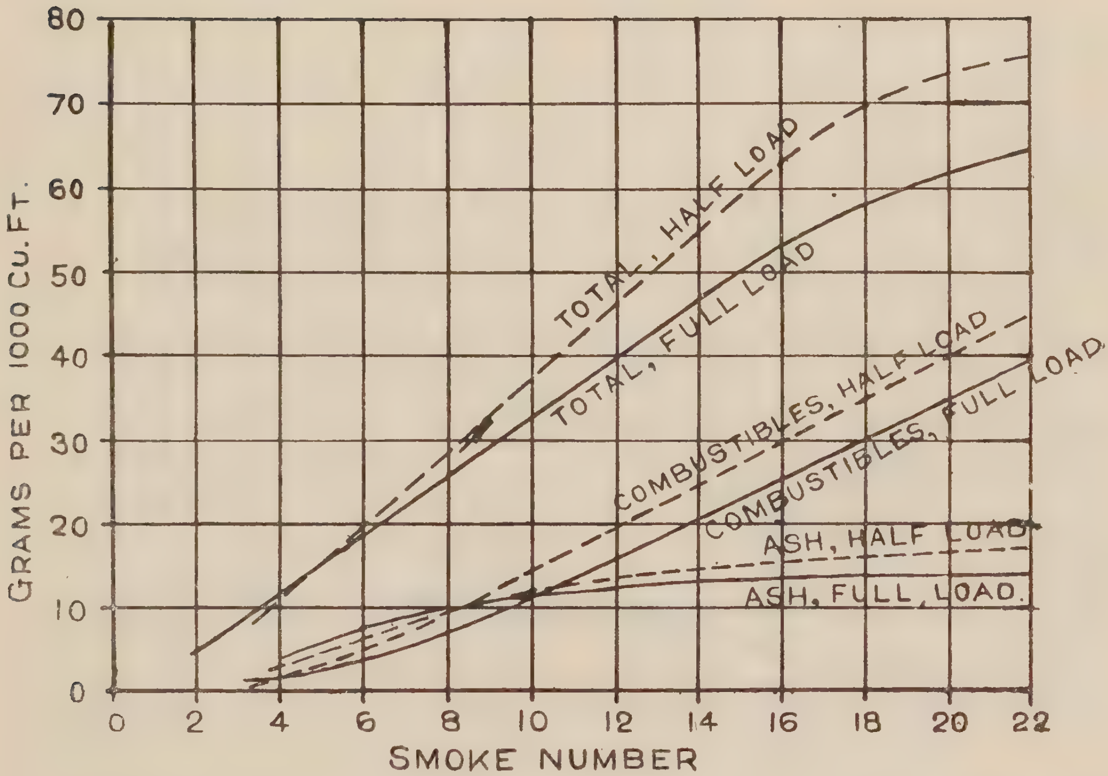


FIG. 2. CONCENTRATION OF SUSPENDED MATTER IN FLUE GASES.

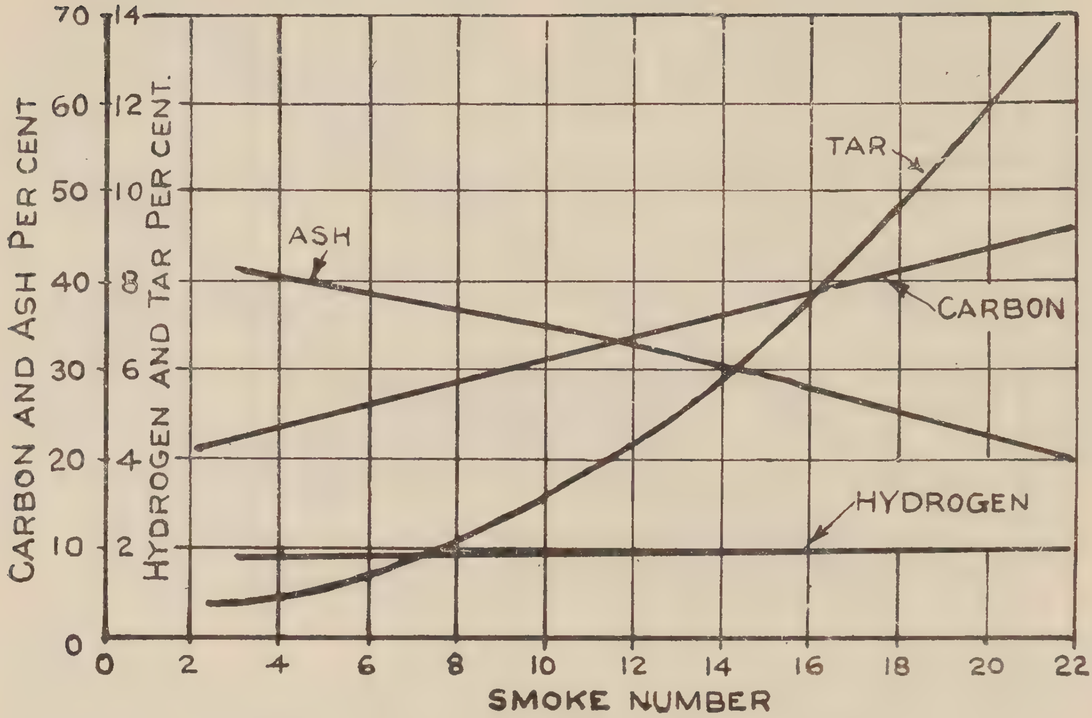


FIG 3 ANALYSIS OF SUSPENDED MATTER-HALF LOAD

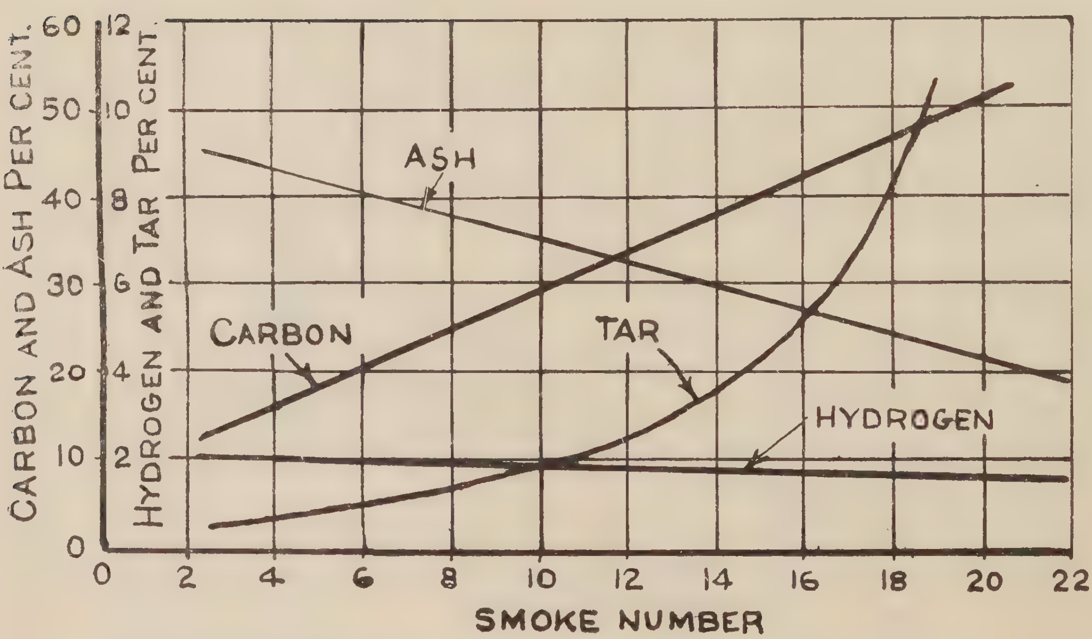


FIG 4 ANALYSIS OF SUSPENDED MATTER-FULL LOAD

pollution.

On the other hand, at any given smoke density, the weight of suspended matter in a unit volume of flue gas was approximately the same at both loads and roughly proportional to the smoke number (Fig. 2). It follows that a rough estimate of the atmospheric pollution from the chimney can be made from the intensity of the smoke, combined with a knowledge of the volume of flue gases passing up the chimney.

The composition of the suspended matter corresponding to smokes of varying intensity is shown in Figs. 3 and 4. The amount of tar was determined by extraction with carbon disulphide, and the "ash" by igniting a portion of the solid residue. The percentages of carbon and hydrogen were determined on another portion of the tar-free residue and corrected to percentages of the total suspended matter. In addition to the tar, carbon, hydrogen and ash, the samples of suspended matter contained some 20 to 40 per cent. of water-soluble salts, such as ammonia sulphate and chloride. The most noticeable feature of Figs. 3 and 4 is the rapidity with which the tarry matter, which is from many points of view the most objectionable feature of smoke, increased with the density of the smoke.

It was also possible in these tests to correlate the flue gas analysis with smoke density as shown in Fig. 5. It will be observed that very little difference occurred in the CO_2 content of the flue gases over a wide range of smoke densities. A figure of 14 per cent., which corresponds to excellent combustion with a light smoke, was also obtainable with a black smoke, from which it is clear that a good CO_2-recorder chart is not necessarily a criterion of good operation. On the other hand, as the smoke became darker there was a pronounced increase in the percentages of the combustible gases CO, H_2 and CH_4. With the darker smokes the presence of these combustible gases is a formidable source of heat loss, as is strikingly shown by Fig. 6 in which the potential heat loss due to combustibles passing up the chimney is plotted against smoke number.

Although the weight and composition of the suspended matter is of importance in connection with atmospheric pollution, the loss of efficiency due to the presence of suspended matter in the flue gas is small compared with that arising from the presence of combustible gases. With dense smoke the latter loss amounted to more than 10 per cent. of the heat in the fuel.

With very light smoke the loss due to incomplete combustion was exceeded by that caused by the presence of too much excess air and, under the conditions of these tests, it would appear that maximum efficiency would be obtained by using about 20 to 40 per cent. of excess air and making a moderate smoke, corresponding to a Number 2 Ringelmann chart.

Smoke of Varying Intensity

When smoke is made in a hand-fired boiler its intensity varies throughout the firing cycle according to the rate of evolution of volatile matter. Immediately after firing, volatile matter is given off quickly and a considerable amount of smoke will be made unless sufficient air for its combustion is admitted over the fire. After a time, most of the volatile matter has been given off and there follows a period with little or no smoke emission. This ends when the fire is disturbed by raking or slicing, giving rise to a further period of smoke emission. This period is in its turn followed by another period with little or no smoke, after which the cycle begins again.

The length of the two periods of smoke emission depends upon the type of coal used, the method of firing, and the time at which raking is carried out. The amount of smoke made depends upon the quantity of air admitted over the fire in conjunction with turbulence and furnace temperature.

Figs. 7(a), 7(b) and 7(c) show the relation between time and the optical density of the smoke, determined by means of a photoelectric cell, during typical cycles when making fairly heavy smoke under the following conditions:

(*a*) with Northumberland singles, firing a Lancashire boiler at 10 minute intervals,

(*b*) with Durham "Deep Sea Bunker" coal, firing a natural-draught marine boiler at 20 minute intervals,

(*c*) with Yorkshire "Mixed Bunker" coal, firing a forced-draught marine boiler at 30 minute intervals.

In Fig. 7(d) a similar curve is given for a domestic fireplace re-fuelled at 35 minute intervals.

It will be observed that in all cases in spite of the difference in the type of plant used, the length of the firing cycle, and the class of coal fired, the curves are

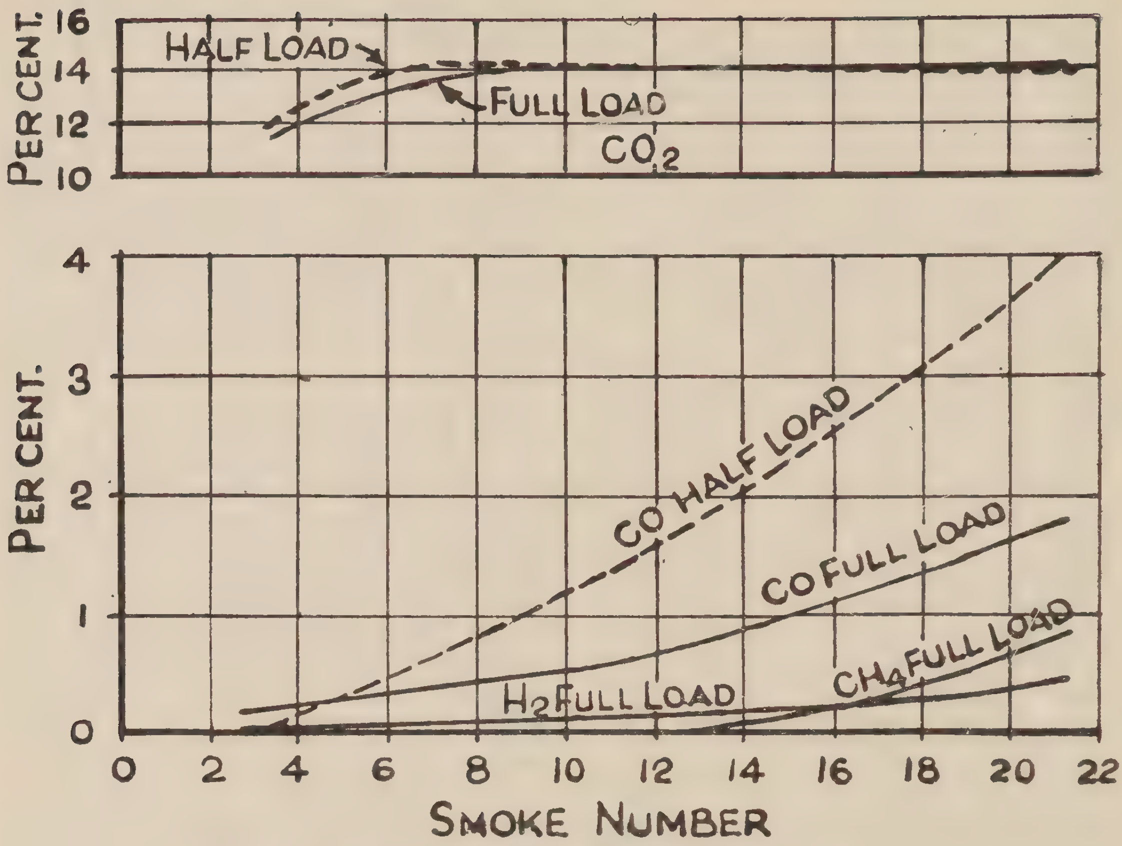


FIG 5 ANALYSIS OF FLUE GAS

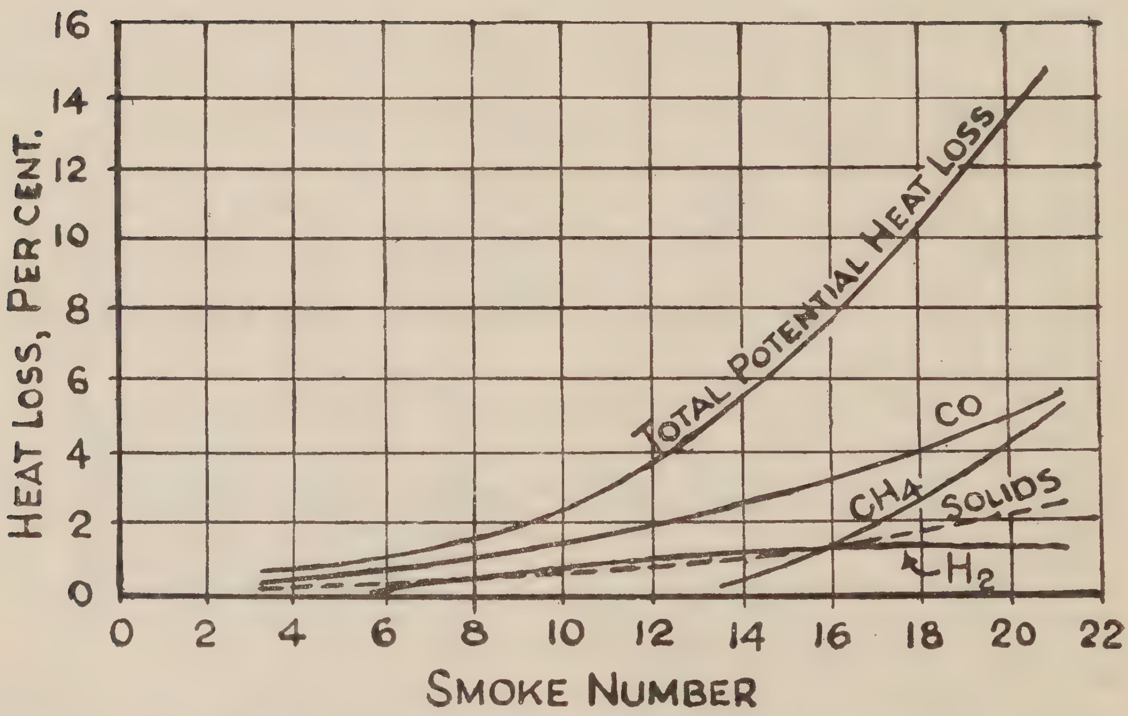


FIG 6 HEAT LOSSES – FULL LOAD

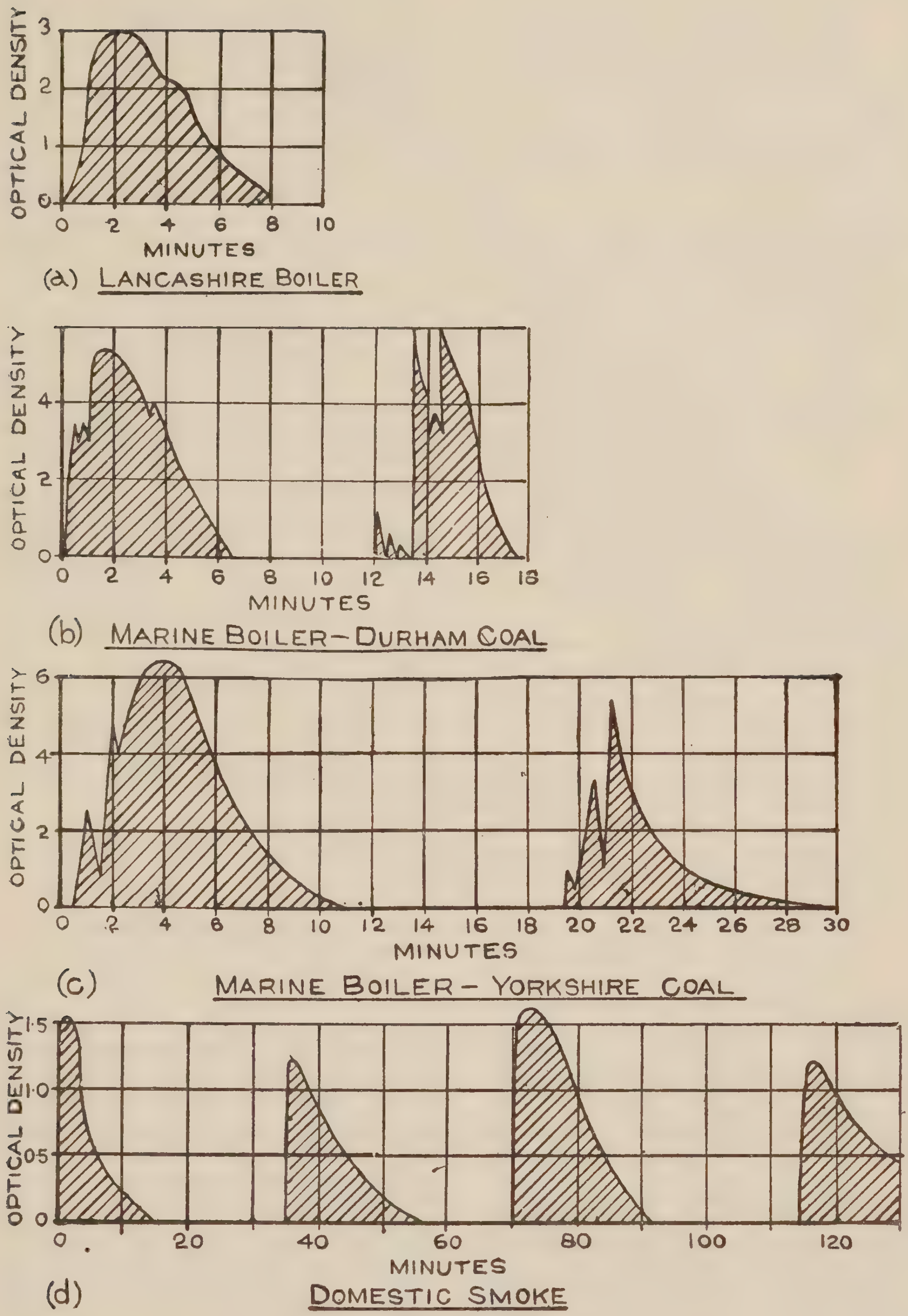


FIG.7 VARIATION OF OPTICAL DENSITY DURING FIRING CYCLE

of the same general shape, and this is emphasised in Fig. 7(e), in which the curves are superimposed to a modified scale. It is of interest to note that the shape of the curves is very similar to that of two additional curves, also given in Fig. 7(e), showing the rate of gas evolution from coal carbonized in a low-temperature laboratory assay apparatus and in low-temperature horizontal retorts, respectively.

Hand-fired Lancashire Boiler

With the short firing cycle of 5 to 10 minutes' duration usually employed with a Lancashire boiler the rate of smoke emission does not remain approximately constant for any appreciable length of time. It is therefore difficult to collect a representative sample of dust at a series of fixed optical densities. On the other hand it is comparatively simple to collect a gas sample with sufficient speed, and an instantaneous reading of optical density can be obtained by means of a photoelectric cell measuring the intensity of a beam of light which has passed through the smoke.

Fig. 8 shows the relation between the optical density of smoke passing up the chimney of a hand-fired Lancashire boiler burning Northumberland singles, and the percentages of CO_2, CO, H_2 and CH_4 in the flue gas. For convenience, optical density is taken throughout this paper to mean $\log_{10} I_o/I_t$, where I_o is the intensity of the original beam, and I_t the intensity of the transmitted light, corrected for a column of smoke 1ft. thick and 60 deg. F.

The gas samples were collected quickly at the peak of the period of smoke emission following firing, using varying amounts of secondary air. It will be observed that, under these conditions, the percentage of CO_2 was high, varying from about 16 with a light smoke to about 14 with a very heavy smoke of optical density 3. It was fairly constant, however, over a large part of the range. The percentages of CO, H_2 and CH_4, in that order, increase steadily throughout the range of smoke intensities.

The results just discussed refer to the instantaneous relations, shown by "snap" samples, between optical density and smoke emission. It is of equal interest to examine any relation which may exist between the average intensity of the smoke and the average composition of the flue gas over a period. By this means, it is possible to get some idea of the effect of smoke emission upon boiler efficiency and fuel consumption.

In Fig. 9 the average optical density of the smoke made during a series of 8 hour trials has been plotted against the corresponding percentages of CO_2, CO and H_2 in the flue gases. In the average samples of flue gases collected over complete trials, the percentage of CO_2 remained almost constant at a little over 13 per cent., over the whole range of smoke intensities. The percentages of CO and H_2 rose steadily as before, while methane was only apparent in measurable quantities with the heavy smokes. Plotted to the same scale Figs. 8 and 9 are almost identical.

It is clear from Fig. 10, in which the heat lost by combustible gases is plotted against optical density, that the production of heavy smoke is accompanied by large heat losses as a result of the presence of invisible combustible gases.

Scotch Marine Boiler

In the course of an investigation into the possibility of reducing smoke emission from merchant ships, a series of boiler trials was carried out on the marine boiler at the Fuel Research Station using strongly caking Durham "Deep Sea Bunker" coal and medium caking Yorkshire "Mixed Bunker" coal as supplied to merchant ships during the war. The trials were made under both forced draught and natural draught conditions, with and without various smoke eliminating devices, and using the 20 to 30 minute firing cycle customary at sea.

With a firing cycle of this length it is possible to collect adequate samples of the suspended matter in the funnel gases during each of the two periods of smoke emission following firing and raking and the comparatively smokeless periods between them. The opportunity was accordingly taken during the trials to collect a large number of these samples, together with the corresponding gas samples, and typical examples of the results obtained are given in Fig. 11. This shows graphically the average dust concentration over the various periods of the firing cycle when operating under similar conditions using natural-draught and making heavy smoke with Yorkshire coal and Durham coal respectively. Fig. 11 also shows in tabular form the corresponding flue gas analyses and the composition of the suspended matter, but these will be discussed generally for the whole series of trials.

For this purpose optical density has been plotted in Figs. 12 to 16 against the concentration of suspended matter in

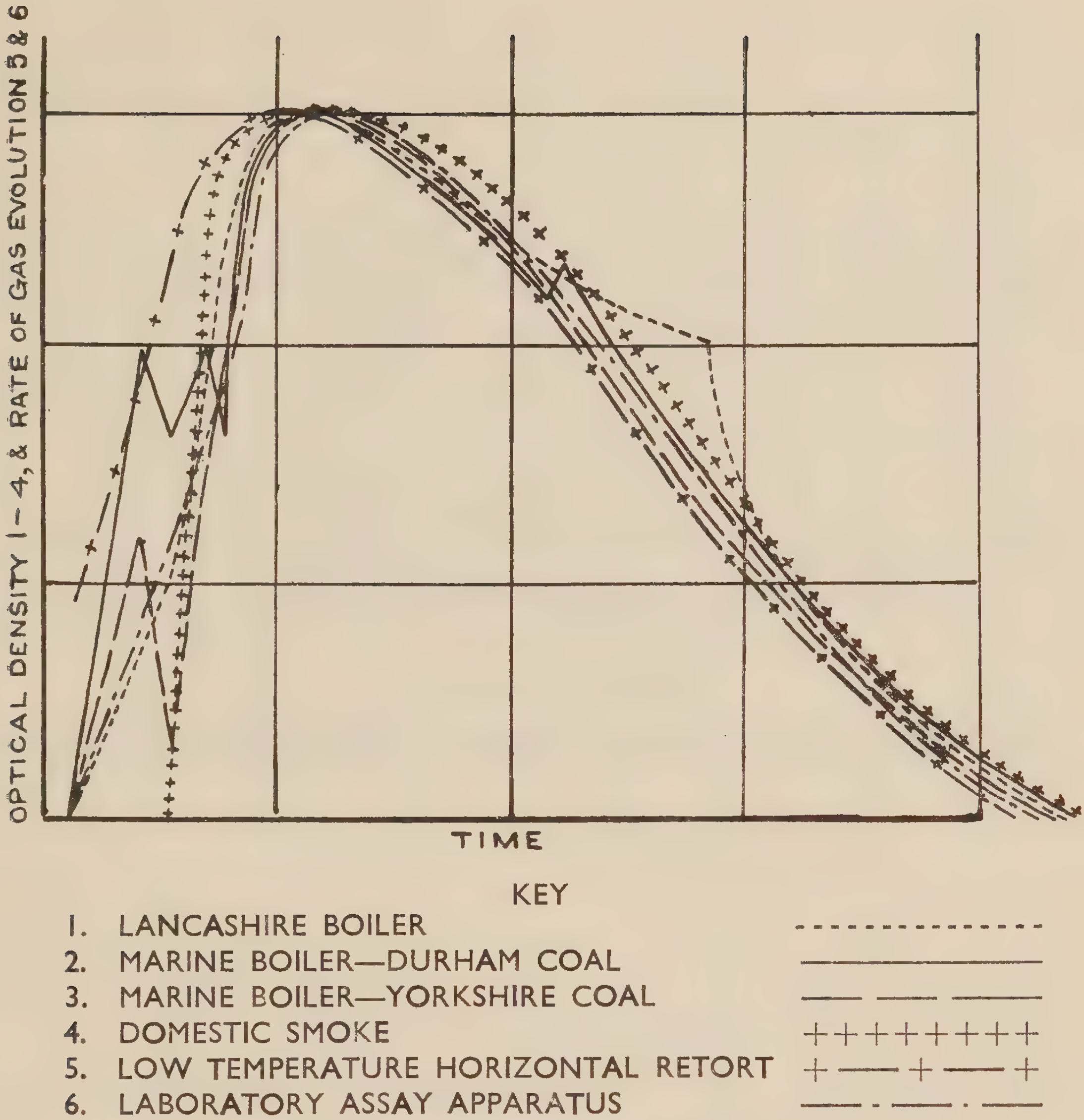


FIG. 7e. COMPOSITE DIAGRAM

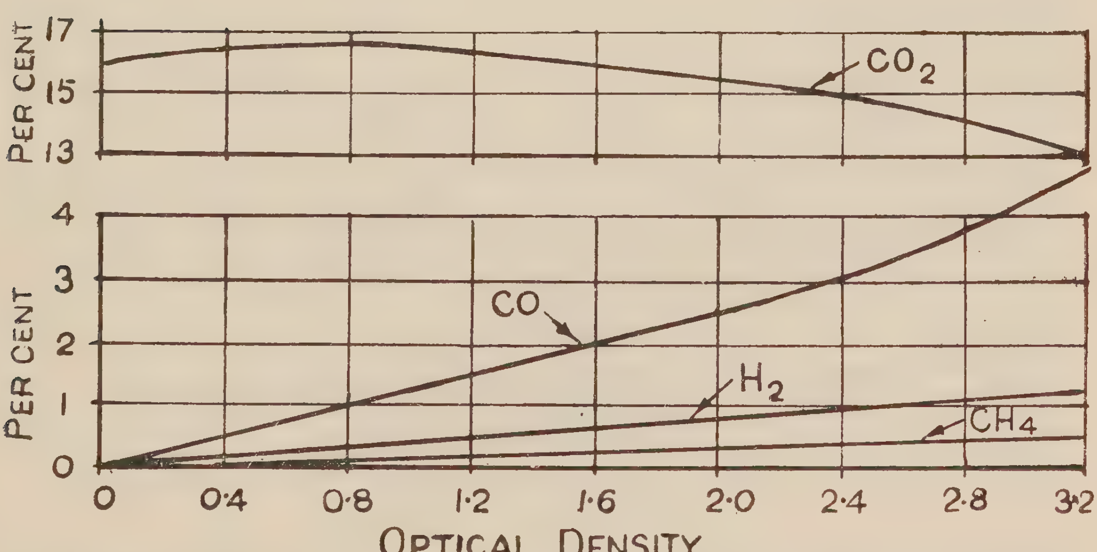


FIG 8. FLUE GAS ANALYSIS–LANCASHIRE BOILER–SNAP SAMPLES

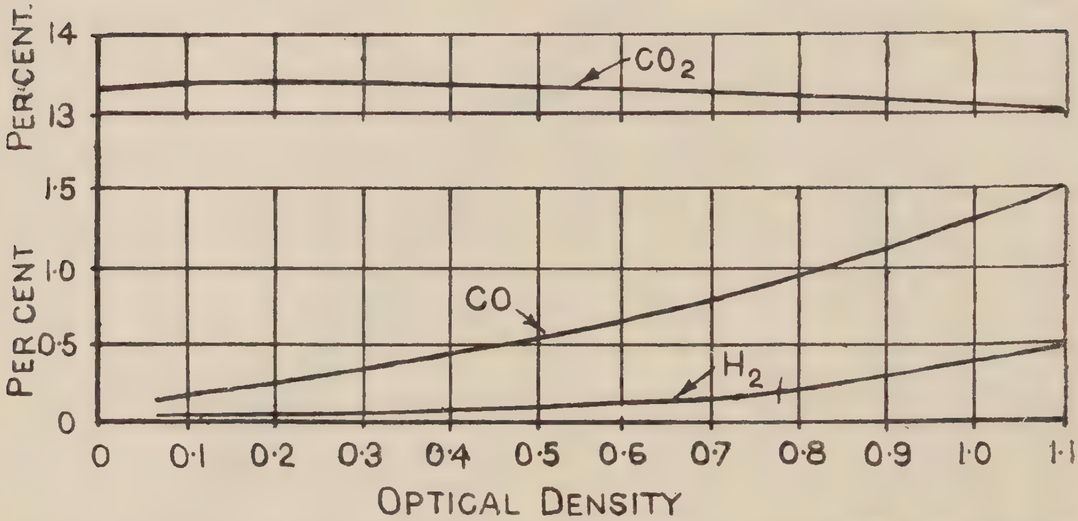


FIG 9 FLUE GAS ANALYSIS-LANCASHIRE BOILER-AVERAGE SAMPLES

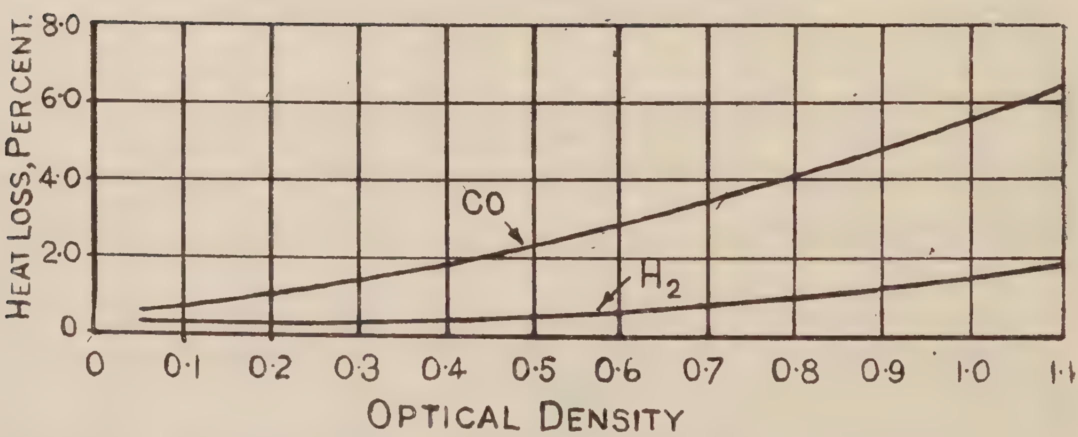


FIG 10 AVERAGE HEAT LOSS IN COMBUSTIBLE GASES.
LANCASHIRE BOILER

the funnel gases and the composition of the funnel gases for the whole series of trials, and against the composition of the suspended matter for the trials with natural-draught. As would be expected from a consideration of the experimental conditions the individual points from which the curves are drawn are somewhat scattered (see for example Fig. 12) but in every case their general trend is clearly defined. Thus, when optical density is plotted against concentration it is found that, irrespective of whether the coal was strongly caking or weakly caking, whether forced draught or natural draught was employed, whether the smoke was heavy or light, and whatever the method of introducing the secondary air and the length of the firing cycle, then all the points group themselves about the same straight line.

As this straight line passes close to the origin, it is evident that, as in the widely different case of a Lancashire boiler fired so as to make smoke of constant intensity, the weight of suspended matter carried up the funnel by the products of combustion tends to be approximately proportional to optical density.

In the trials carried out with natural draught, determinations were made of the percentages of ash, tarry matter, and of the carbon in the tar-free residue, on a large number of samples of suspended matter. The relation between these quantities and optical density are shown in Fig. 13. Presumably because of the difficulty of analyzing very small quantities of material, the points with the lighter smokes with optical densities up to about 2 were scattered, but above that density they conformed closely to the curves drawn through them.

As in the case of the Lancashire boiler (Fig. 4), there was a decrease in the proportions of ash and an increase in the tar and carbon as the optical density increased, but the percentages of tar and carbon were much smaller with the marine boiler. This may well have been because the furnace conditions with regard to turbulence and temperature were more conducive to the production of " distillation " smoke during the tests on the Lancashire boiler.

Over a wide range of smoke intensities, the percentage of CO_2 in the funnel gases (Fig. 14) remained approximately constant at about 13 to 14 per cent. With very light smoke it tended to fall, presumably owing to the use of larger proportions of excess air; with the heavier smokes it also tended to fall, but for the opposite reason, i.e. a deficiency of excess air.

The remaining curves in Fig. 14 show that, as in the case of the Lancashire boiler, the percentages of CO, H_2 and CH_4 increase steadily with increasing smoke density. The same trends are followed in the corresponding curves in Fig. 15, for averages over complete trials.

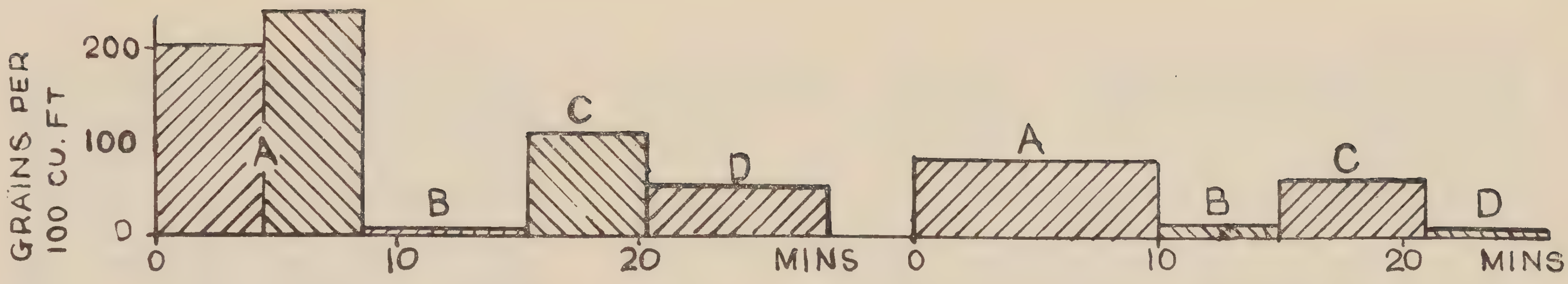
The average heat losses from incomplete combustion are given in Fig. 16, the most interesting feature of which is the small amount of heat in the suspended matter compared with that in the combustible gases. Even with a very heavy smoke the total heat lost in the suspended matter is only about 2 per cent. of that of the fuel burned and only one-sixth of the total heat losses which in some trials exceeded 10 per cent. of the heat value of the fuel.

It might be objected that losses of this magnitude do not occur in ordinary practice as a result of making smoke, but such losses were recorded during trials carried out in a typical merchant ship fired in the ordinary way during a normal commercial voyage.* In the same ship a saving equivalent to 5½ per cent. of the fuel consumption was achieved merely by using a device developed during the war to reduce smoke for tactical reasons. Moreover, analysis of the trial results suggests that, by modifying the apparatus and the method of firing to reduce the smoke still further, an even greater saving would have been possible.

Domestic Smoke

Wide as are the differences in the design of the combustion equipment and in the methods of firing employed in hand-fired boiler furnaces, the corresponding divergences in domestic fireplaces are still more pronounced. In particular, the manner in which air passes through the fuel bed and the extent to which the products of distillation and combustion are cooled by, and mixed with, secondary air differ enormously, while the method of stoking varies with the idiosyncrasies of each user. It is not surprising, therefore, to find wide variations in the figures given for the composition of the flue gases and of the " smoke " by various authorities. Thus the percentage of CO_2 is said by some to be of the order

* Department of Scientific and Industrial Research, Fuel Research Technical Paper No. 54.—The Reduction of Smoke from Merchant Ships. H.M.S.O. 1947. Price 1s. 3d.



YORKSHIRE COAL

PERIOD	A		B	C	D
CONCENTRATION OF SUSPENDED MATTER.					
GRAINS/100 CU FT	202	238	11	109	52
COMPOSITION OF SUSPENDED MATTER-PER CENT					
CARBON	83·9	89·1	57·9	85·7	87·8
TAR	10·1	6·0	1·3	5·6	3·7
ASH	4 5	3·8	21·6	6·8	4·9
WATER SOL	1·5	1·1	19·2	1·9	3·6
COMPOSITION OF FLUE GAS - PER CENT.					
CO_2	11·66	12·89	14·85	13·36	13·82
CO	1·00	2·87	0·16	1·65	0·36
H_2	0·01	0·57	0·00	0·52	0·08
CH_4	0·27	0·49	0·01	0·13	0·00
O_2	6·78	3·56	3·95	4·25	5·76
N_2	80·28	79·82	81·03	80·09	79·98

DURHAM COAL

A	B	C	D
CONCENTRATION OF SUSPENDED MATTER.			
78	15	59	9
COMPOSITION OF SUSPENDED MATTER PER CENT			
85·2	55·3	87·4	45·8
7·9	3·2	3·7	11·2
5·9	34·7	7·5	32·7
1·0	6·8	1·4	10·3
COMPOSITION OF FLUE GAS - PER CENT.			
12·78	13·51	13·99	13·44
2·14	0·97	1·96	0·50
0·57	0·06	0·45	0·10
0·01	0·05	0·02	0·00
5·43	5·23	3·43	5·98
79·07	80·18	80·15	79·98

FIG. 11. VARIATION IN COMPOSITION OF SUSPENDED MATTER AND FLUE GAS DURING FIRING CYCLE.

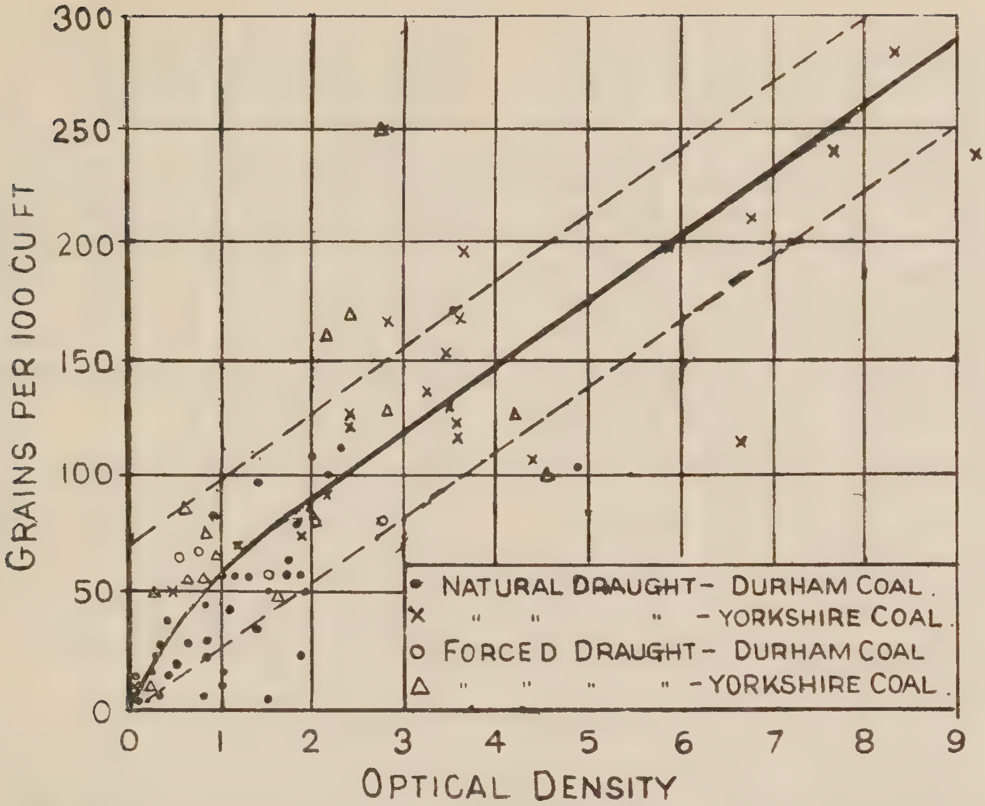


FIG 12 CONCENTRATION OF SUSPENDED MATTER IN FLUE GASES

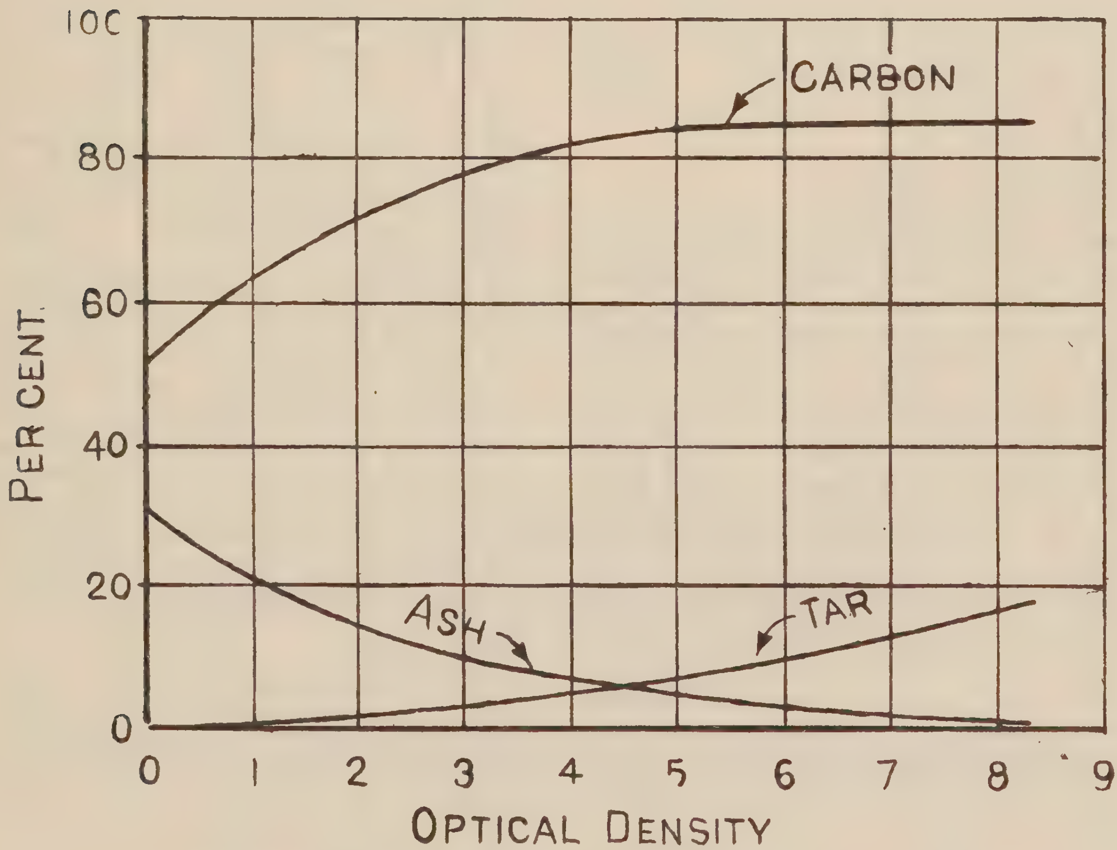


FIG 13 ANALYSIS OF SUSPENDED MATTER

of 0.2 to 0.3 per cent. and by others to be 1.2 to 2 per cent. Early investigators estimated the weight of soot produced to be about 5 per cent. of the fuel burned, but more recent work, including tests at the Fuel Research Station, suggests a more general figure of about 2 per cent.

Owing to the very high dilution of the chimney gases by air there is considerable difficulty in estimating accurately the total heat loss due to incomplete combustion in domestic fireplaces. Such figures as are available suggest that the total heat loss is of the order of 15 to 20 per cent. of the fuel fired, of which only about 2 per cent. is in the suspended matter.

In general terms, the smoke from domestic fireplaces, like that from industrial furnaces, can be divided into two broad types, "distillation" smoke and "cracked" smoke, the type evolved from any particular fireplace being determined largely by the rank of the coal used and the period in the fuelling cycle. Both types were made in a series of tests at the Fuel Research Station in which smoke samples were collected during periods when the optical density of the smoke was reasonably uniform. The coals used covered the whole range of caking indices; nevertheless, as in the case of the industrial chimneys, the concentration of suspended matter in the chimney gases was always directly proportional to the optical density of the smoke (Fig. 17).

Correlation of Results

Before attempting to correlate the results already given it must be pointed out that they were obtained on full-scale commercial equipment and in some cases in the course of trials which did not have as their main object the determination of a relation between optical density and the composition of smoke. It must be admitted that the plants were in good condition and that every care was taken to get representative samples, but the control was not comparable with that achieved in the laboratory. Thus, several stokers were employed who had varying degrees of skill, the quality of the coal may have changed slightly from hour to hour, and the distribution of the smoke in the chimney may have varied with atmospheric conditions.

There were also deliberate changes, e.g. in the rank of the coal and in the furnace equipment. It was therefore to be expected that, as indeed was the case, the experimental points would fall in bands rather than precisely on curves. Nevertheless, the general trend of the results is remarkably well defined.

The outstanding feature is that, in spite of the wide variation in conditions, the optical density of the smoke was always approximately proportional to the concentration of the suspended matter. Although the range of optical densities covered in the various series was wider in some cases than in others, when the curves from Figs. 2, 12 and 17 are plotted together (Fig. 18) it would appear that with any type of coal, with smoke of constant intensity from a Lancashire boiler, or of variable intensity from a marine boiler, or with smoke from a domestic fireplace, the same relation holds between optical density and smoke concentration. The inference is that it is at least probable that the same relation may hold when smoke is made under other conditions.

This agreement does not apply to the actual composition of the suspended matter, but this would not be expected; it is unlikely, for example, that "cracked" smoke would contain as much tarry matter as "distillation" smoke.

With the industrial boilers the percentage of CO_2 in the flue gases differed slightly in different plants, possibly due to varying degrees of air infiltration, but it is noteworthy that there was little variation in the average percentage of CO_2 over the full range of smoke intensities (see Figs. 5, 9 and 15). This observation follows from the fact that a small change in the percentage of secondary air results in a large variation in smoke production.

It is to be expected that the percentage of CO, H_2 and CH_4 in the flue gases with any given smoke density would vary with furnace conditions, but with any particular equipment there was a regular increase in the percentages of CO and H_2 in the flue gases with increasing smoke density. In all cases the percentage of H_2 was about one-third that of CO. The proportion of CH_4 is more irregular, but becomes important with the darker smokes.

There is also general agreement in the heat loss in the suspended matter, which throughout varies from 0 to about 3 per cent. of the heat in the fuel, according to the amount of smoke made. This heat loss is in all cases small compared with that in the combustible constituents of the flue gases.

Summary and Conclusions

An attempt has been made to correlate

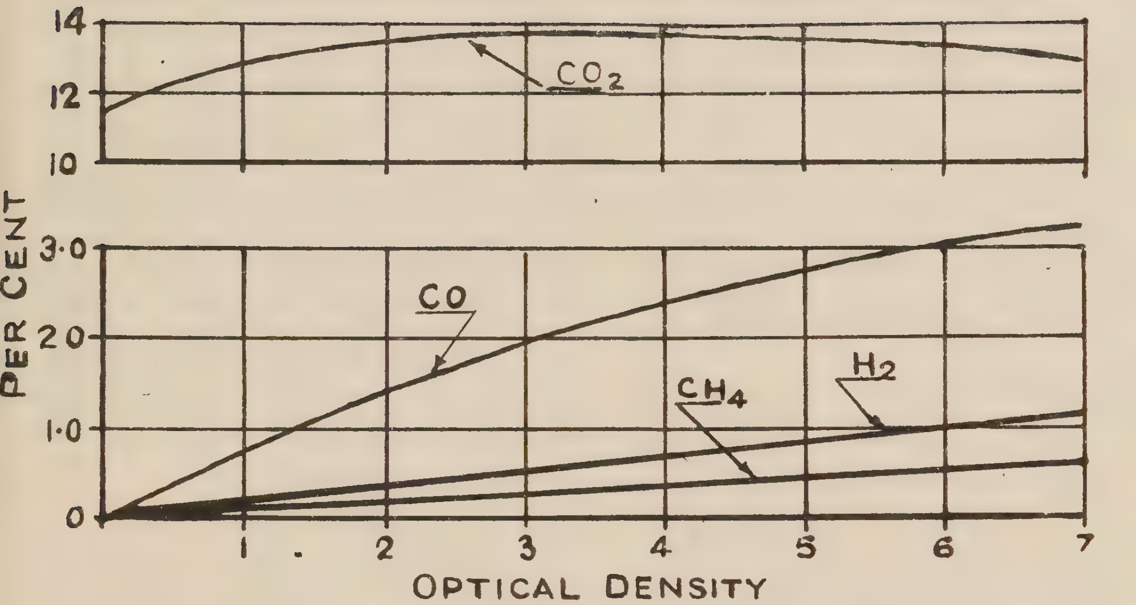


FIG. 14. FLUE GAS ANALYSES – MARINE BOILER SNAP SAMPLES.

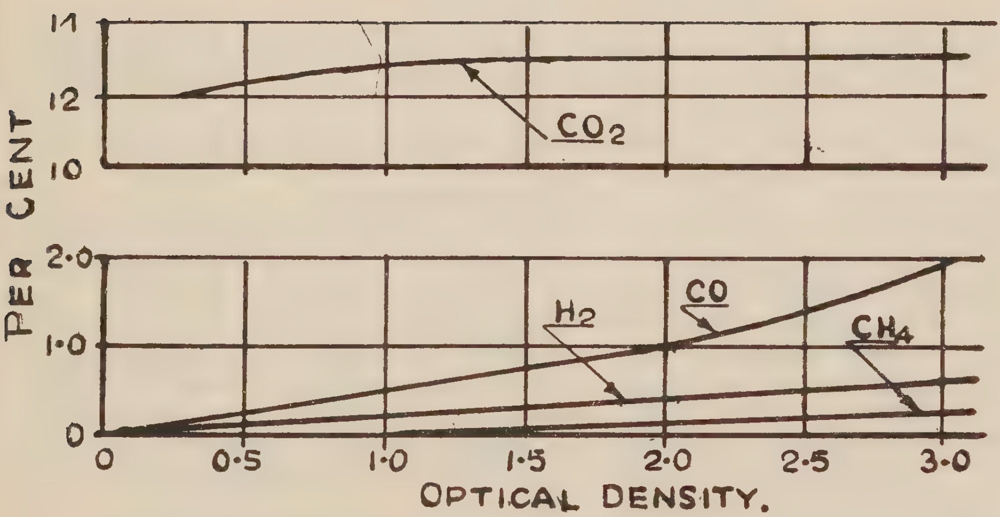


FIG 15 FLUE GAS ANALYSES – MARINE BOILER. TRIAL AVERAGES.

the optical density of smoke with the concentration and composition of the suspended matter carried by the flue gases, and with the analysis of the flue gases. The relevant experimental data were collected while burning a wide range of coals with varying firing conditions in a hand-fired Lancashire boiler, a hand-fired Scotch marine boiler, and a domestic fireplace.

In all cases the optical density of the smoke was approximately proportional to the concentration of the suspended matter and the same relation appeared to hold with each appliance, irrespective of the type of coal fired or the method of firing.

The composition of the suspended matter varied with the furnace conditions, although the percentages of tarry matter and carbon always increased with increasing smoke density.

The composition of the flue gases also varied with the furnace conditions. With the industrial boilers there was little difference in the percentage of CO_2 over the whole range of smoke densities, but the percentages of CO and H_2 increased steadily with increasing smoke production, the percentage of H_2 being usually about one-third that of CO. With the heavier smoke appreciable amounts of CH_4 were present, but not in a fixed ratio with the CO.

The combustible gases CO, H_2, and CH_4 were present in sufficient quantity to account for a serious heat loss, which, with heavy smokes was equivalent to over 10 per cent. of the heat value of the fuel burned. On the other hand, the heat lost in the suspended matter was comparatively small, and even with very dense smoke was only about 2 per cent. of the heat value of the fuel.

From the point of view of atmospheric pollution, the implication is that the optical density of the smoke gives a direct indication of the extent to which a particular chimney is responsible for pollution by "smoke" provided the volume of the flue gases can be estimated. From the point of view of thermal efficiency and fuel consumption the results show that the production of dark smoke indicates a serious waste of fuel. Only a small proportion of this waste is in the potential heat of the visible smoke particles, most of it arising from the presence of the invisible combustible gases associated with smoke production.

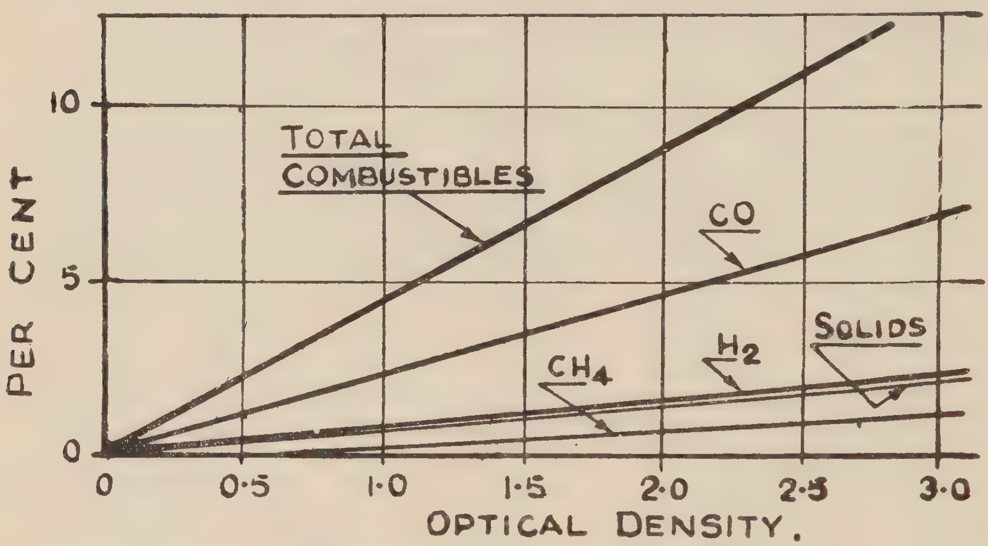


FIG. 16. HEAT LOSSES-MARINE BOILER-TRIAL AVERAGES.

Acknowledgments

The experiments described in this paper formed part of the programme of the Fuel Research Board of the Department of Scientific and Industrial Research. The paper is published by permission of the Director of Fuel Research. The illustrations are Crown Copyright and are published by permission of the Controller, H.M. Stationery Office.

The author wishes to acknowledge the assistance given to him by his colleagues, Messrs. W. J. Sparkes, L. J. Flaws, R. Lambie and W. Hill, in the collection of data and in the preparation of results and illustrations; and by Mr. L. L. Fox, who collected the information on domestic smoke.

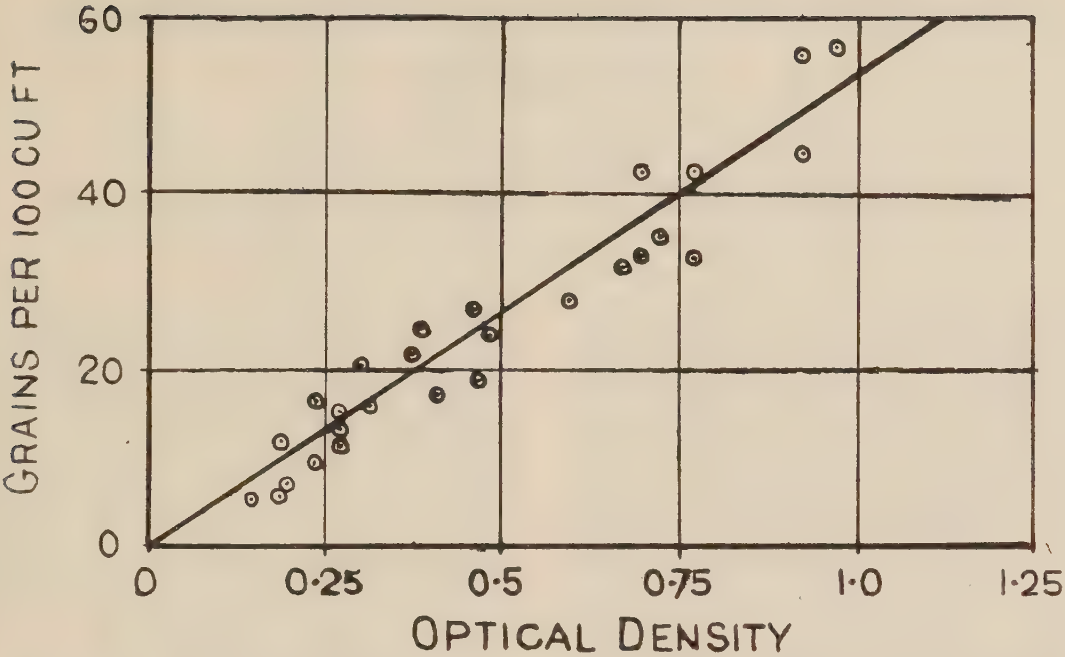


FIG 17 CONCENTRATION OF SUSPENDED MATTER
DOMESTIC FIRE.

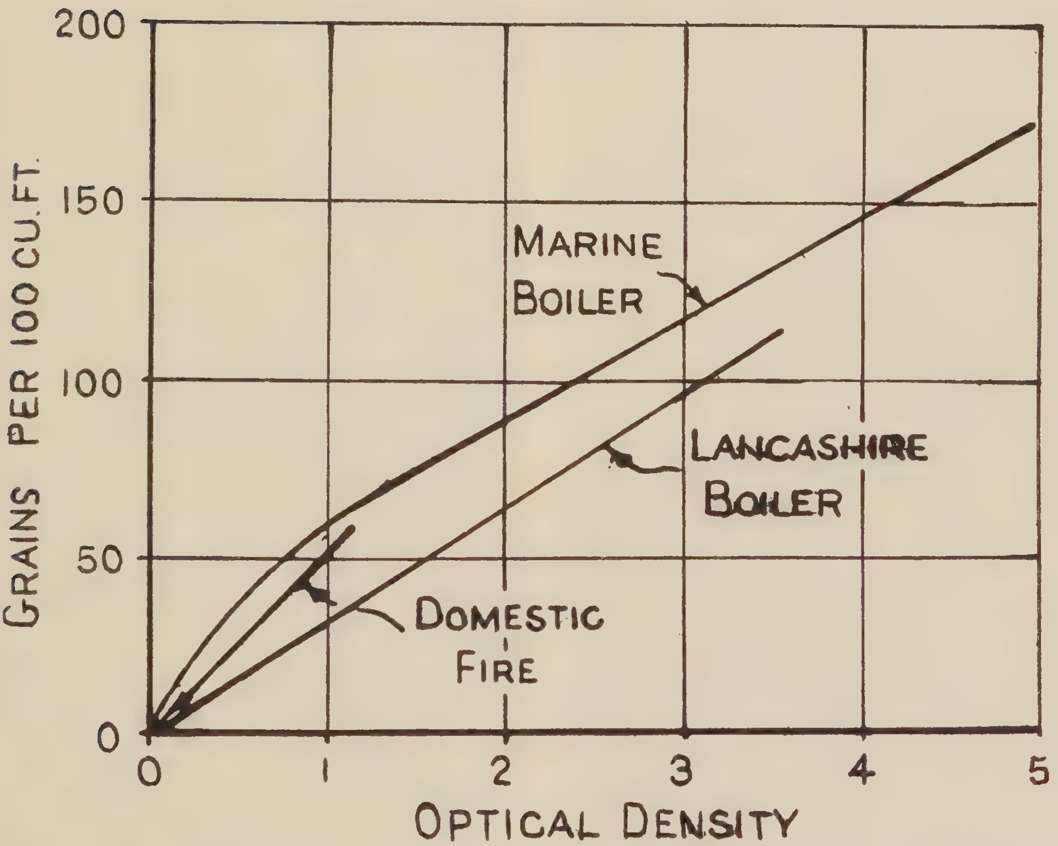


FIG 18 CONCENTRATION OF SUSPENDED MATTER

A21

The Measurement of Atmospheric Pollution

By A. R. MEETHAM, M.A., D.Phil.,
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THE movement for the systematic investigation of atmospheric pollution in Great Britain may be said to date from the conference of delegates of municipal authorities and others held in connection with the Smoke Abatement Exhibition in 1912. Observations were already being made in London, Glasgow, Leeds and elsewhere, and the need was felt for these efforts to be co-ordinated. It was obviously desirable that the information obtained by different observers should be reasonably comparable for the same place, from month to month, from season to season, and from year to year; also for different places for the same periods. A committee for the Investigation of Atmospheric Pollution was therefore appointed in 1912 to "draw up details of a standard apparatus for the measurement of soot and dust and standard methods for its use."

The work of the Committee continued with the help of a "grant-in-aid" by the Department of Scientific and Industrial Research, which was established in 1916. It is interesting to note that the grant in aid of atmospheric pollution research must have been one of the first grants made by the Department. Annual reports of observations and research were published. The first Standard Deposit Gauge was described in 1916 and observations were reported going back to 1914. The Owens Jet Dust Counter was described in 1923, the Owens Automatic Filter in 1924, and several other important instruments were developed by this energetic committee through the great inventiveness of the Honorary Secretary, Dr. J. S. Owens. In 1927, the financial arrangements of the Committee were reorganized, part of the cost being borne by subscription, from various local authorities, and other bodies who either maintained observations or who were especially concerned about atmospheric pollution, and the remainder of the cost being borne out of the grant of the Department of Scientific and Industrial Research. The Committee which has become known as the Meteorological Office (Air Ministry) Advisory Committee on Atmospheric Pollution was dissolved. Two new Committees were constituted by the Department of Scientific and Industrial Research, a large one, representing the interests of the co-operating bodies (as they came to be called) and a small one of specialist advisers on research under the chairmanship of Dr. G. C. (later Sir George) Simpson, Director of the Meteorological Office.

These arrangements have persisted with little change until the present day. The small Committee is called the Atmospheric Pollution Research Committee. Dr. G. M. B. Dobson, F.R.S., has been its chairman since 1934. It was reconstituted in 1945 as a committee of the Fuel Research Board, and it was empowered to consider the prevention of atmospheric pollution; as well as its measurement. This did not of course imply that previously no work has been done in the Department of Scientific and Industrial Research on prevention of pollution. As is evident from the paper of T. F Hurley before the meeting, considerable research had already been done by the Fuel Research organization on the prevention of smoke and other forms of atmospheric pollution. The large committee is now known as the Standing Conference of Co-operating Bodies,

It is evident from this very short historical account that measurements of atmospheric pollution are made primarily because they are needed by the Bodies who are taking active steps to reduce pollution. The central work of designing and standardizing equipment and methods of observation arose because of the desire of these Bodies to co-operate instead of working independently. The problems of measurement have naturally led to the design and improvement of instruments and methods. The problems of interpretation of measurements have led to fundamental research in the behaviour of smoke and other atmospheric pollution

from the time when it is released into the open-air. Some of the fundamental problems are very interesting indeed, and their answers, if they are satisfactorily solved, may have a bearing on meteorological and other matters quite distinct from smoke abatement; but the reason for all this work remains unchanged: the need to reduce atmospheric pollution everywhere to negligible proportions.

Smoke. The Atmospheric Pollution Research Committee divides atmospheric pollution into gases, large particles which are deposited fairly quickly near to their place of origin, and small particles (including smoke) which remain suspended in the air for a long time. In the limited time and space available it is necessary to confine attention to one particular form of atmospheric pollution, and the obvious choice is smoke. By smoke is generally meant the visible particles of combustible matter which are given off when certain fuels, especially coal, are incompletely burned. After escaping from the chimney and mixing with the air, these particles are observable as a haze or "smoke-pall" when the total weight of them in the line of sight is of the order of 0.5 gram per square metre. To give an idea what this means, it takes about 7 lb. of distemper to whiten a ceiling of area 25 square yards; on the basis of 0.5 gram per square metre it would take ½ oz. of smoke to blacken it. As far as is known, no one has weighed the smoke on a dirty ceiling, but ½ oz. seems likely to be a reasonable figure.

The majority of smoke particles are so small that they do not sink to the ground under their own weight, whereas a high proportion of other particles, such as ash and coal dust, fall fairly quickly to the ground. In consequence of these facts, if the particles in a volume of town air are collected and analysed, about 85 per cent. of their weight will be found to be "combustible matter," with only 15 per cent. of "ash." For many purposes, therefore, it is permissible to regard the suspended matter in the air as identical with the true smoke emitted from chimneys or other sources. Most of the simpler ways of measuring atmospheric smoke are founded on this approximate identity.

The earliest form of smoke filter recommended by the Committee was described in 1917 as "A method of measuring suspended impurity in the atmosphere." A measured volume of air was drawn, by water power, through a disc of special filter paper, leaving the suspended impurity on the paper as a greyish stain ⅛″ in diameter. The discolouration of the paper was compared with a prepared scale of shades, which was independently calibrated by collecting and weighing large amounts of smoke. and comparing a fraction of each weighed sample with the scale. In a modified form the filter is still in use. It has been found convenient to use an electric air pump for drawing the air through the filter paper, to draw air continously for 24 hours, and to obtain smoke stains of ½″, 1″ or 2″ in diameter.

The Owens Automatic Filter has been used day and night for thirty years for obtaining hourly smoke stains; it too, is only a modification, though a highly ingenious one, of the original "method of measuring suspended impurity." There have been other developments, such as a photoelectric method of comparing smoke stains, and several suggestions for obtaining smoke samples in weighable amounts, but the simple smoke stain remains the most generally used device.

Results. Table 1 gives an idea of the average amount of smoke to expect in winter at the centre of towns of various sizes. Observations in actual towns were used for this table, but the figures for the smaller towns were estimated from observations in the suburbs of Leicester.

It will be seen that on the whole the concentration of smoke goes up with the population, but there are certain exceptions. Cardiff, with only about a quarter as much smoke as other towns of the same size, has the reputation of being an exceptionally clean city. The commonly accepted reason for this is the practice of burning low-volatile coal in domestic grates instead of bituminous coal. At Stoke, the concentration of smoke is higher than at other towns of the same size. In 1938-9 when the observations were taken, it seems likely that the industries of Stoke were producing more smoke than those of other towns.

The figures in Table 1 are average figures, day and night, for the five winter months, November to March. It is well-known that at certain times of day, notably about 8 o'clock in the morning and 6 or 7 o'clock in the evening, there is usually more smoke in the air than at other times. Also the variation from day to day of smoke is very noticeable. On the blackest winter day, the concentration of smoke may be six or seven times the winter average.

Table 1. Dependence of Smoke on Population

Town	*Wind Directions*	*Population*	*Average Winter Smoke mg./100cu.m.*
Leicester :			
Station 10	NE, E, SE	10,000	7
Stations 4 and 5 ...	SW, W, NW	30,000	15
Station 3	S, SW, W, NW	60,000	19
Station 2	SE, S, SW, W	100,000	18
Station 14 ...	N, NE, E, SE, S	140,000	23
Coventry	all	200,000	30
Cardiff	all	220,000	8
Leicester (Stn. 1) ...	all	260,000	33
Stoke-on-Trent ...	all	270,000	59
Kingston-upon-Hull...	all	320,000	34
Dublin	all	320,000	42
Edinburgh	all	440,000	51
Glasgow	all	1,090,000	66
London	all	8,200,000	84

Properties of Smoke. In 1937, at the recommendation of the Atmospheric Pollution Research Committee, an intensive survey was begun of the smoke and other forms of atmospheric pollution in Leicester. Along with other objects it was hoped to find the general distribution of smoke within a town, and also to learn something about the "life history" of smoke after it had left the chimney. Only a few of the results of the survey can be quoted here.

Figure 1 shows the average winter distribution of smoke in Leicester and Figure 2 shows the corresponding distribution of ultra-violet daylight. It will be seen that about 30 mg. of smoke per 100 cubic metres is responsible for a 25 per cent. loss of ultra-violet radiation.

A point of great interest is the effect of wind on the distribution of smoke. Figure 3 shows the distribution of smoke for light and moderate winds in summer and for light, moderate and strong winds in winter, the intersection of the straight lines indicating the centre of the city. At first it is very surprising that, in all cases, the highest pollution is found close to the centre of the city, rather than some distance downwind from the centre. The general distribution, indicated by the circles, is remarkably little distorted by the wind.

The discovery of these facts led to a new series of tests at Leicester which, unfortunately, was cut short by the war, The measurements were all made at or near street level and it would have been desirable, though it was very difficult, to make similar measurements at heights of 500 or 1,000 ft. It was possible, however, to show that the smoke, though not present in large quantities in the surface air on the downwind side of Leicester, was present above the surface; for the amount of daylight cut off by smoke was appreciably greater downwind than at the centre of Leciester. Airmen will confirm that the smoke sometimes rises to great heights a short distance downwind from industrial cities.

Turbulence. The meteorological factor responsible for lifting smoke from the surface into the upper air is known as turbulence or eddy diffusivity. It is related to the wind and also to the temperature gradient in the air: in the middle of a sunny day there is always much more turbulence than at night, or in the early morning or evening. The upward diffusion of smoke is probably the most important factor in limiting the concentrations town-dwellers have to breathe. If it were not for upward diffusion, the concentrations of smoke in surface air would be enormous.

In spite of the beneficial effects of turbulence, it is well-known that smoke spreads from towns to the surface air of neighbouring districts. During easterly winds the air entering Leicester was always cleaner than in winds from the north, west, or south. Even at the centre of Leciester, between one-tenth and two-fifths of the smoke came from other areas. The smoke from the Birmingham district, West Riding and Derbyshire, Lancashire and Staffordshire, and from London was detected and shown to be consistent with an inverse-square law.

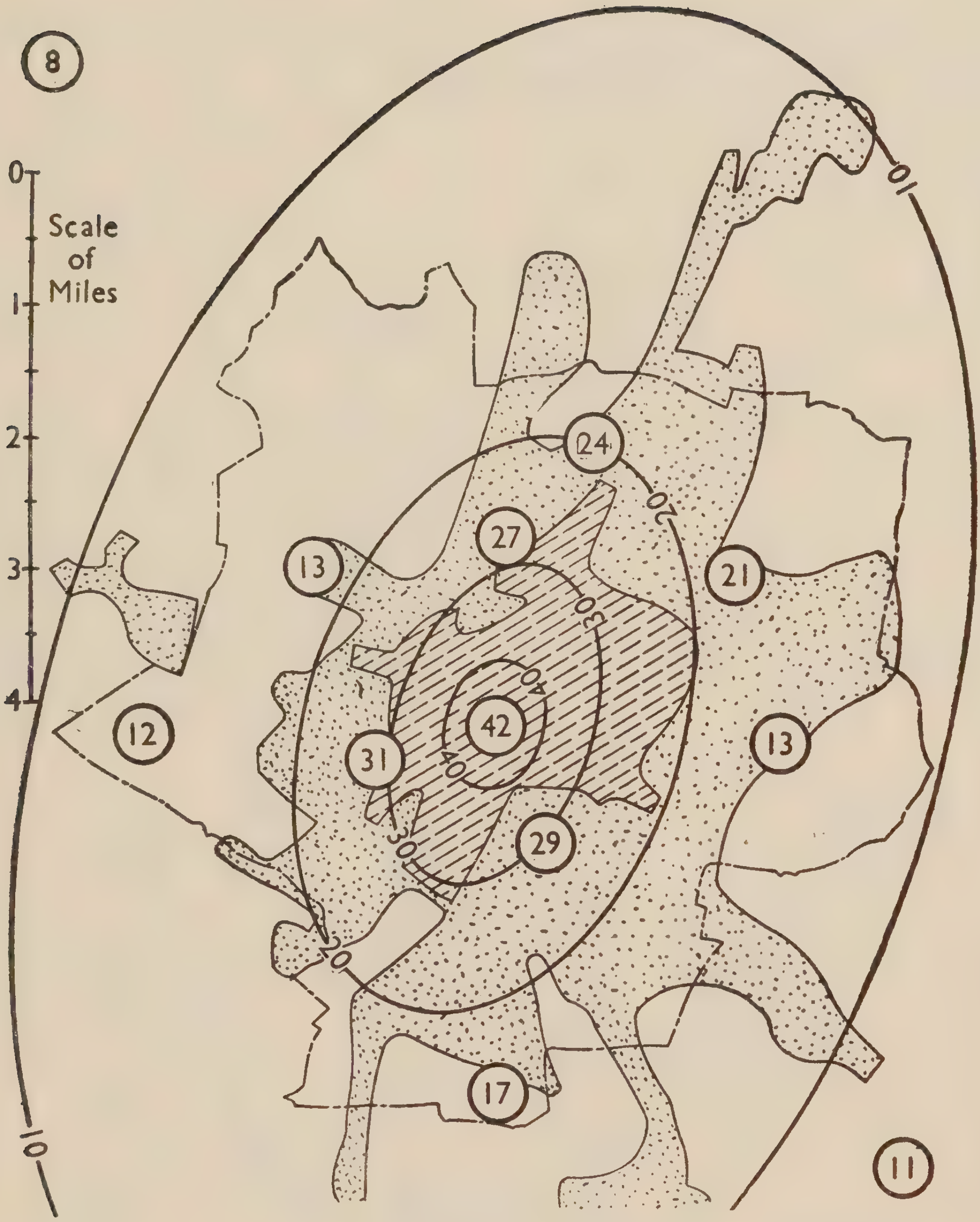

Fig. 1. Average Winter Distribution of Smoke in Leicester. *This closely built-up area is hatched. The stippled area represents houses with gardens.*

Rapid Surveys of Smoke. The results of the Leicester Survey showed that the amount of smoke in the surface air of town was very variable indeed, but that its general distribution, in certain conditions of weather, was much less variable. By this is meant that, in a given wind direction, for example, the amounts of smoke at particular points in a town are always in approximately the same ratio, even though there may be everywhere two or three times as much smoke on

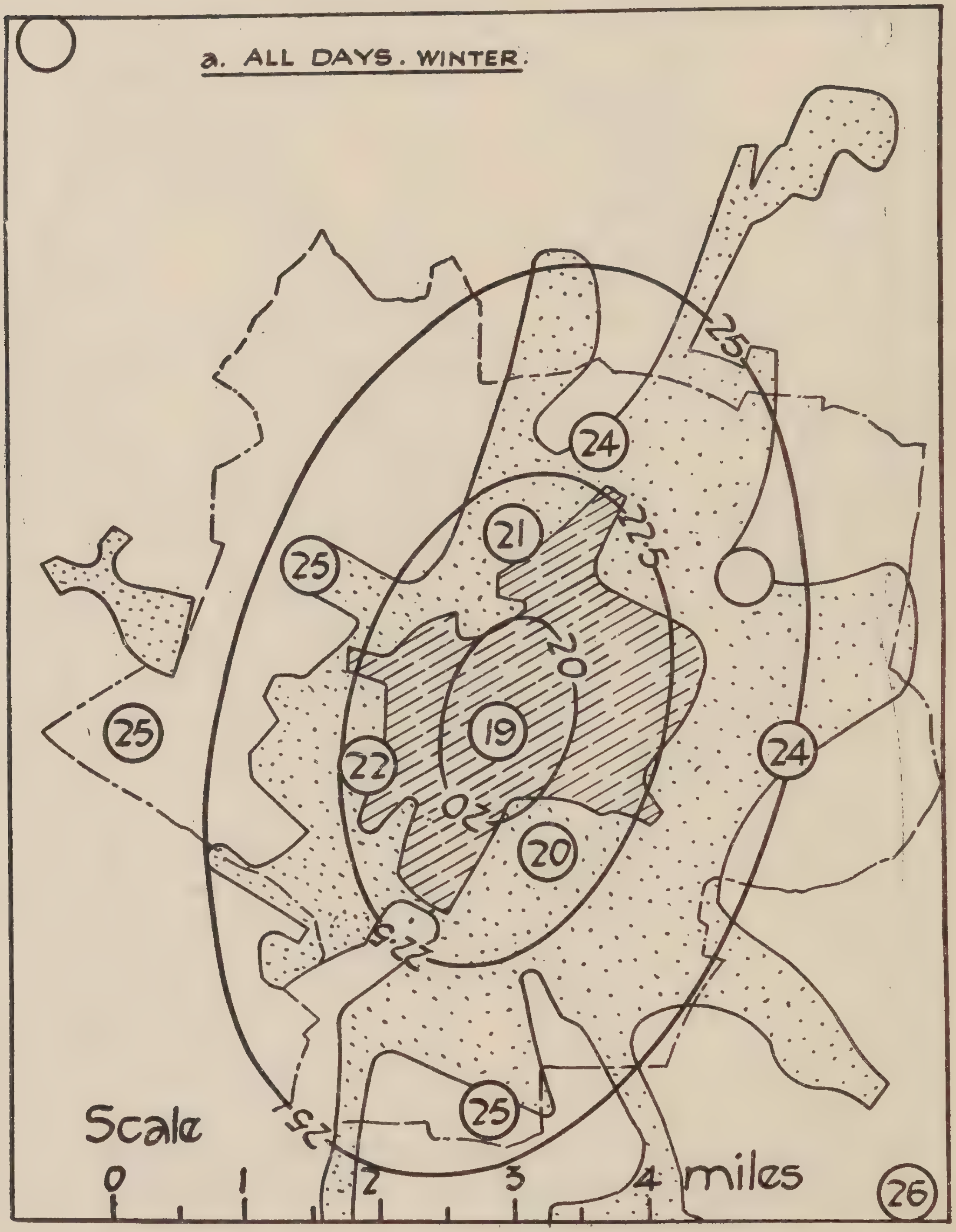

Fig. 2. **Average Winter Distribution of Ultra-Violet Daylight.**
Numbers are minutes per day with the sun at 45° in a blue sky.

one day as on the next.

It is now possible to make a rapid survey of the distribution of smoke over an area, using a simple hand-pump to obtain smoke stains on filter paper, similar to those described in an earlier section. In the course of two or three hours, smoke samples can be obtained at twelve or more positions half to one mile apart. The resulting estimates can be plotted on a map. Figure 4 shows the distribution of smoke in and near Hyde Park, London, during March, 1943.

The hand-pump is tedious and tiring to use. An obvious improvement would be to replace it by an electric pump, driven by a car battery. When small 12-volt electric motors become available, it is hoped that there will be further developments in rapid surveys of smoke.

The importance of measurement. As was explained earlier in this paper, the work of the Department of Scientific and Industrial Research on the measurement of atmospheric pollution has risen in response to a definite demand for information, from Local Authorities, Government Departments, and other bodies concerned with its reduction or elimination. It is easy to see why measurements are necessary, in addition to direct action in abating smoke.

A very interesting book was published last year by the Ministry of Fuel and Power and the Department of Scientific and Industrial Research, entitled "Domestic Heating in America." It contains a chapter on smoke abatement in St. Louis, where the use of bituminous coal is now strictly controlled. The story of the remarkable achievements in St. Louis is complete except for one most important piece of information; no one knows, or will ever know, how great a reduction of smoke was effected by the regulations. If suitable measurements had been made in 1936-9 and 1940-3, before and after the smoke regulations were passed, St. Louis could have been praised in concrete instead of abstract terms. Moreover, the results could have been used as arguments in favour of other cities following suit.

Whenever a change in atmospheric pollution, either for better or worse, is likely to occur, it is worth while for the authorities concerned to consider two questions: (1) How much good or harm is going to be done to our air? (2) How necessary is it for a quantitative answer (a) to be known by us and (b) to be published for the benefit of other communities?

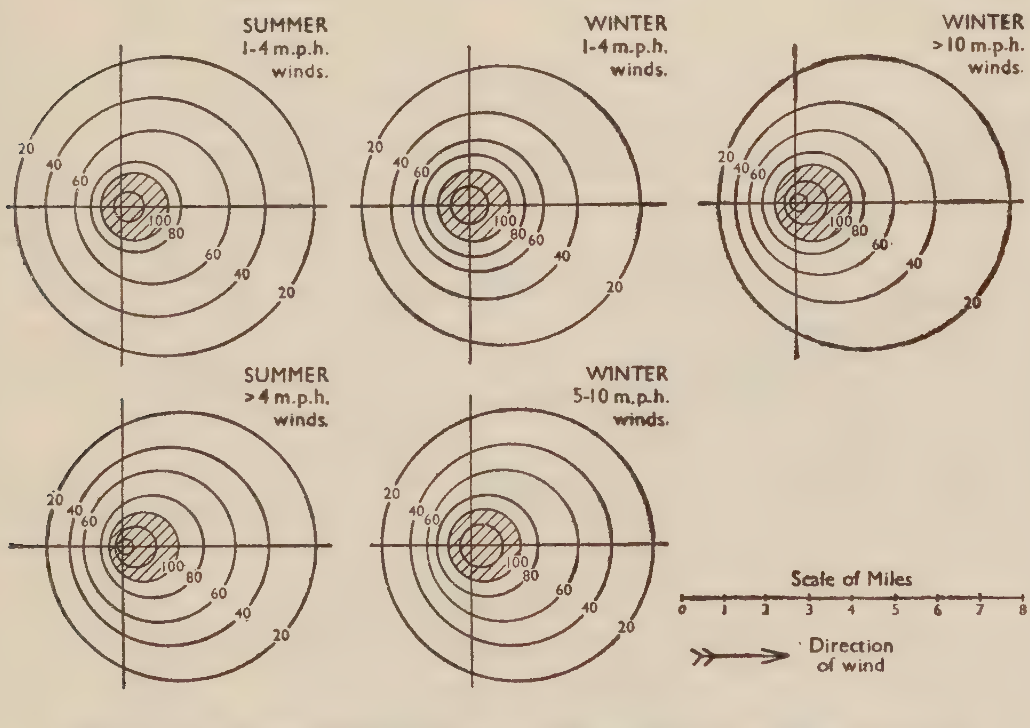

Fig. 3. Effect of Wind on Smoke Distribution in a Symmetrical town the same size as Leicester. ***Arbitrary units.***

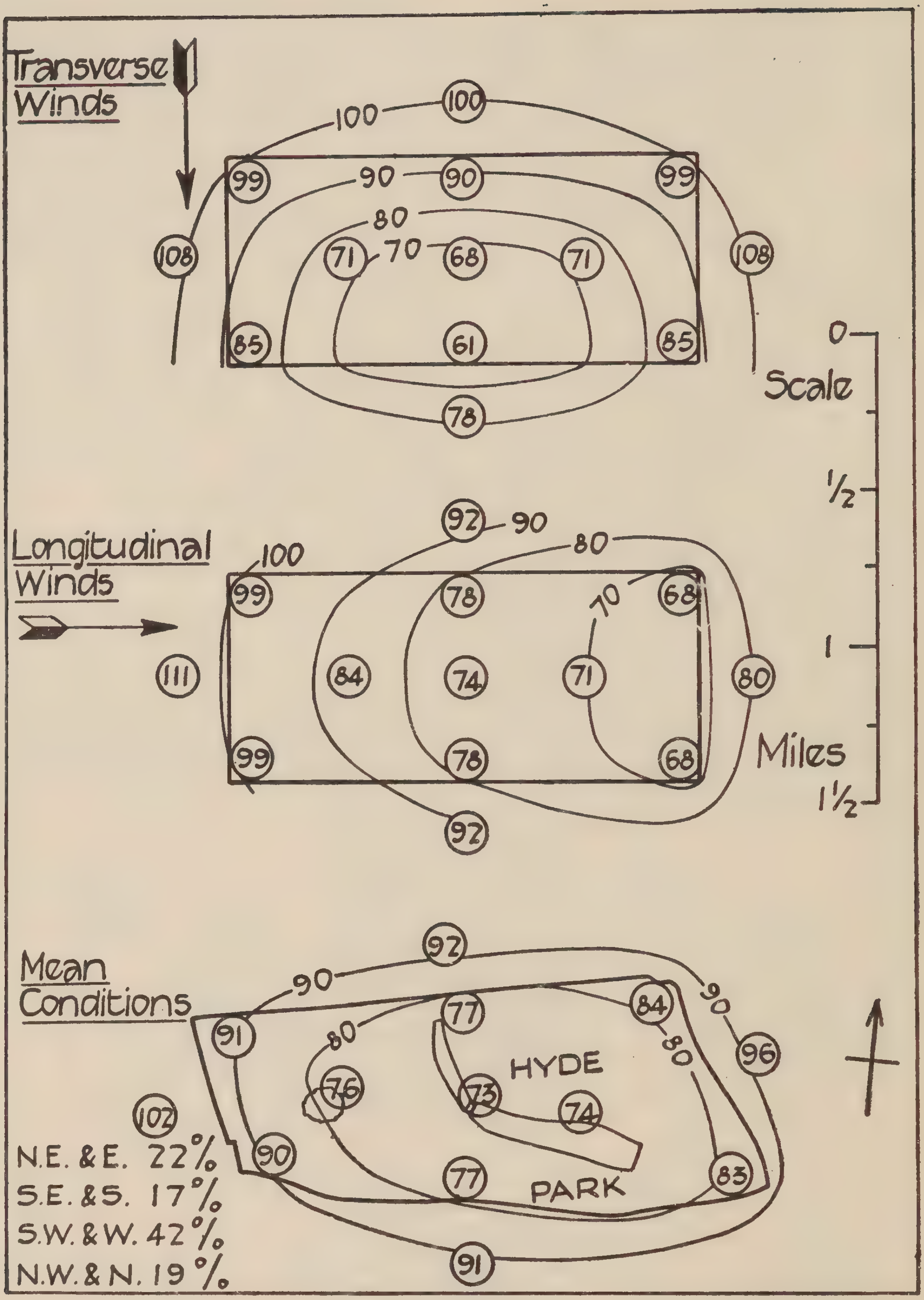

Fig. 4. Smoke in Hyde Park.

Expressed as percentage of smoke concentration upwind from the Park.

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(2) The Ministry of Fuel and Power

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Smoke Abatement and Fuel Efficiency

By J. EDWARD,

Regional Fuel Engineer, Scotland, Ministry of Fuel and Power

THE first officially recorded figure of deep-mined coal production was in the year 1854, when the production was nearly 65,000,000 tons compared with production in 1939 of 231,000,000 tons. The industrial revolution brought about this tremendous increase in the use of coal. Undoubtedly the fact that coal was in cheap and plentiful supply led to its being used inefficiently and this in turn led to the smoke nuisance which has been with us for so long.

Before the war it was very difficult to stimulate active interest in smoke prevention despite the hard work put in by a number of public-spirited people and organizations such as this Society. The war changed the position. The drop in coal production made it necessary for steps to be taken to improve the efficiency with which fuel was burned, and in 1942, the Government set up the Fuel Efficiency Division of the Ministry of Fuel and Power to see that this was done. The organization was a temporary one, but is now being placed on a permanent basis. It is fortunate that practically every step taken to increase combustion efficiency reduces atmospheric pollution and, in particular, smoke.

The work of the Division falls, naturally, into two sections, one dealing with the domestic use of fuel, i.e., the use of fuel in the home and in blocks of flats and office buildings, and the second with the industrial use in factories.

The Domestic Uses of Fuel

The domestic consumer was responsible before the war for one-third of the total consumption.

What is being done then to improve efficiency?

During the war, as far as the domestic user was concerned, almost the only way in which he could save fuel was by not using it. Regional Domestic Fuel Efficiency Organizers were appointed to preach economy and, of course, the consumption of solid fuel was restricted so that, inevitably, domestic pollution decreased.

The end of the war has, however, permitted a more positive approach to the problem of domestic fuel efficiency, and the Domestic Section of the Fuel Efficiency Division has now turned its attention to this task. The Government has had the benefit of the report prepared by the Fuel and Power Advisory Council, whose Chairman, Lord Simon, had for so long been actively interested in the problem of smoke abatement.

As was reported at the annual conference of your Society, an Inter-Departmental Committee was set-up on Domestic Heating to arrange for the Council's recommendations, which were accepted in principle by the Government, to be implemented. As a result of the activities of this Committee and of the work of the Ministry of Fuel and Power, Regional Fuel Engineers and Domestic Organizers, progress is being made in this programme; the large rebuilding programme offers a unique opportunity for improving the standard of fuel efficiency as well as the standard of comfort in homes.

One of the main recommendations of the Council was that the main winter space heating and hot water load should be borne by solid fuel. The Council considered that the supply of smokeless fuel available to the domestic consumer should be increased and that appliances installed on domestic premises should all be capable of burning smokeless fuel. During and since the war, the production of improved types of appliances has been considerably developed. These appliances are usually multi-duty, providing, for example, both space heating and hot water, continuous burning and capable of consuming smokeless fuel. Their average working efficiency is, at least, 40 per cent. and in many cases higher.

A list of appliances of this type, suitable for installation in low costs house, has been prepared and sent to Local Authorities by the Ministry of Health, with a recommendation that they should be installed. As new appliances

become available the list is added to, and it is hoped that in due course only improved appliances will go into subsidized houses. Showrooms are to be opened shortly by the Ministry of Fuel and Power in London and Glasgow, to demonstrate these appliances.

One of the difficulties in the past in raising the standard of fuel efficiency was the higher cost of the more efficient appliances. The Ministry of Health have agreed, however, to give Local Authorities every encouragement to install these more expensive appliances. The efficiency of the appliances at present available varies over a fairly wide range, but the target performances standards agreed between the manufacturers and the Domestic Heating Committee represent a very real advance.

Installation Information

The appliance, of course, is not the only factor which needs to be taken into account. The appliances must be properly installed. The Ministry of Fuel and Power have arranged for detailed installation drawings to be prepared for a number of appliances included in the list of those recommended to Local Authorities. These drawings should be available to architects and builders shortly. It is hoped that manufacturers in general will undertake the preparation of similar installation instructions for each of their appliances as they come on the market. Many manufacturers are, of course, already supervising the installation of their appliances and it should be possible to develop this service still further.

The Fuel and Power Advisory Council appreciated the need for educating housewives in the use of solid fuel appliances. This is an acute problem with the improved types of appliances which are going to achieve fuel efficiency and smoke abatement. They require skilful management if the desired results are to be obtained. The Minister of Fuel and Power, Regional Fuel Engineers and Domestic Organizers have already undertaken some work in this field, e.g., in connection with the stoves installed in the temporary houses. This is now being extended to cover the whole field. Activities in this Section are serving to build up a body of information on the faults and advantages of the different appliances. The information obtained in this way will be passed on to manufacturers and in this way it is hoped that rapid progress in development can be obtained.

Existing Houses

There remains the problem of existing houses. The Fuel and Power Advisory Council recommended that the Government should encourage the replacement of appliances in existing houses. This will be considered by the Domestic Heating Committee in due course, but for the present, the production of appliances is barely more than adequate to meet the demands for the new housing programme. In order to encourage replacement where this is desirable and practicable, the Ministry of Health recently agreed that provided the appliances are available and the amount of building labour required for the replacement is small, a licence for the installation might be issued outside the normal licensing allocation of the local authority concerned.

The housing programme also provides an opportunity for smoke abatement by way of district heating schemes. An Inter-Departmental Committee has been set up to consider proposals submitted to the Ministry of Health by local authorities. Nearly thirty schemes have come before the Committee and the bulk of these have been approved; two of these are already under construction—others will follow. In the boiler houses providing the hot water for these schemes, bituminous coal can be burned with the minimum amount of smoke.

What of the supplies of smokeless fuel?

On a short-term basis it may prove possible to divert some of the smokeless fuel now being used in industry to the domestic market to be used with the new appliances. Increased production is, however, a problem which is receiving the close attention of the National Coal Board.

The Industrial Problem

The task of directing the improvement of efficiency on the Industrial side has been carried out, very largely, by Minister of Fuel and Power Regional Fuel Engineers and their staff. In many cases, additional equipment or replacement has been necessary. During the war the possibilities of providing these were restricted; licences for material were issued only when it could be shown that the resultant saving in fuel would repay the capital cost of equipment over a

period of 2½ years, later extended to 4 year.

The end of the war has eased the material supply position somewhat and, at the same time, the need for increasing the efficiency in industrial consumption has been emphasized by the large increase in demand for fuel.

In industry control of combustion and therefore of smoke emission is generally much easier than is the case with the domestic fire, and if the domestic chimney is to be classed as "public enemy No. 1" from the point of view of smoke emission, the factory chimney is the main culprit in another direction—that of grit emission.

Grit Emission

Grit emission is largely dependent on chimney draught and the low draught of the domestic chimney leaves it free from grit. The difficulty of fuel supplies to industry has in a vast number of cases, led to "degrading" of quality. In order to burn poorer grades of coal at a sufficiently high rate of combustion to obtain sufficient heat release from the furnace, the air supply had to be greatly increased in many cases by the introduction of mechanical draught. Furthermore, industrial fuels now carry a greater proportion of fines than formerly and this aggravates the "Grit" nuisance. The increasing use of intensive machine-mining methods means that in future fuels will contain a greater proportion of fines than ever before, and the "Grit" emission problem from industrial public utility and other chimneys is likely to be one of the major problems of post-war smoke abatement.

At the present time coal-fired electricity stations are the source of complaints. This is due to high demand causing overloading of steam generators and also to the degrading of fuel. Generating stations and large industrial plants consume vast quantites of coal at one location, so that though emission per ton of coal fired may be small, the large tonnage consumed can create a local nuisance. Electric stations are, however, large enough to be able to install the most modern and efficient grit-arresting apparatus. Furthermore, as at Battersea Power Station, London, the gases can be "washed" to remove the oxides of sulphur which are such a harmful constituent of smoke.

There are available cyclone type-grit arrestors for smaller plants which can remove perhaps 80 to 90 per cent. of the grit according to conditions and a well-known firm of combustion engineers is now experimenting with an improved type which should prove of great value to industry.

The smaller industrial plants present a very great problem. Heavy expenditure on equipment is often impossible. The personnel are often quite unskilled and some attendants have other duties to perform. This type of plant, however, is gradually becoming more efficient and an inducement to this end has been the rising price and scarcity of coal. Improved appliances, advancement in technical training, steam linkage—one boiler-house supplying several factories—are indicated as lines of progress.

Much can, therefore, be done by modern appliances to reduce grit and smoke in the very large plants, but more than half of the industrial coal used is burned in small and medium-sized plants. A vast amount can be done in reducing smoke and grit by applying just a little sound commonsense. The proper control of industrial furnaces requires education and practice. The fireman is a skilled craftsman and ought to be regarded as such.

Stokers' Classes

Classes for stokers, pioneered by the Smoke Abatement Society and subsequently extended by the Ministry of Fuel and Power, have been well attended and successful. New education plans are now in hand which will, it is hoped, provide a ladder by which the ambitious man can climb from the firing floor to membership of the Institute of Fuel. The Fuel Efficiency Committees throughout the country, who have been observing the results of these "Stoker Classes," are enthusiastic and the difficulty is to arrange classes and find lecturers to meet the demand. The surest way to eliminate smoke and grit from coal is to ensure that it is not wasted. A trained stoker uses less coal, saving smoke, grit, and money. The actual amount used is burned efficiently, which again reduces the emission.

It is worth noting that these "Stoker Classes" were originally designed as a means to smoke abatement. They are now being promoted with a view to efficient utilization of fuel.

As a further means to fuel efficiency the Ministry of Fuel and Power has appointed Stoker-Demonstrators: practical men who are available to give instruction on the firing floor and generally

to help train stokers and managements to obtain the very best results from the fuels made available to them.

That part of the smoke problem connected at present with central heating is only a passing one and is mainly due to fuel supply difficulties. Hand-fired coke or anthracite is smokeless, so also is bituminous fuel when fired by a suitable stoker. Smoke occurs when bituminous coals are hand-fired on C.I. Sectional Boilers, for this class of fuel is not suitable for such equipment and would not be used on this type of plant under normal conditions.

The Sanitary Inspector or Smoke Abatement Officer, working with the Stoker-Demonstrators of the Ministry, has done excellent work in this field, and this liaison will be strengthened further.

Now that the Fuel Efficiency Division of the Ministry of Fuel and Power has been established on a permanent basis, this work of improving the efficiency with which fuel is burned, and the resultant reduction in smoke abatement, will go on. Progress will depend, too, on the public interest which is shown, and here local authorities have an opportunity to play a very big part. On the domestic side they can see that the improved appliances are installed and can educate the housewife to see that they are correctly used. On the industrial side they are in a position to set a good example by their own practice!

The extended use of the services of the Research Engineer in narrowing the gap between existing knowledge and the application to manufacture is is of first-rate importance.

Such problems as the adequate provision of solid fuel, uniformity of quality and grading are receiving the close attention of the National Coal Board.

The efficient use of fuel and smoke abatement are practically synonymous, but it is only through the strong and continued co-operation of all sections of the public that the campaign can be brought to a successful conclusion.

Discussion

G. C. Smith (Combustion Appliances Makers' Association and C.U.J.C.), agreed with Mr. Edward on the grit nuisance which arises from the present quality of fuel supplies. Stoker makers believed that by intelligent use of forced and induced draught and of the eids flue and chimney dampers, fairly good results might be secured and the Stoker Classes to which Mr. Edward had referred had been most helpful in this respect.

If stabilized coal quality could be obtained, modern types of mechanical stokers and of grates would enable a thin level fire to be maintained at all times, and this with a balanced draught would very materially reduce smoke and grit emission. The wrong type of fuel or large variations in its grade might, however, compel the boiler attendant to maintain very large fires with a chimney draught sometimes as high as 2″ W.G. No grate could burn all types of fuel with equal efficiency, and in switching from one type of fuel to another combustion difficulties were bound to occur. He uttered a word of warning to those who might contemplate changing over to a smokeless form of fuel such as coke, on account of its slower rate of burning and a consequent lower steam output.

Boiler users should remember that there was a limit to the amount of steam their existing plants could generate and should consult the stoker manufacturer and boiler maker before increasing the demands on it made by additional plant. Many cases of smoke and grit emission were due to forcing the fires to secure extra steam from a boiler too small for the job.

Stabilized coal quality was vital to the efficient utilization of solid fuel. Stabilized specifications were more important than ultra-clean or closely-sized fuels. With modern equipment their adoption would virtually eliminate smoke, enable maximum efficiency to be attained and materially reduce the labour required on the firing floor. The appliance maker would further be enabled to design and produce for greatly enhanced efficiencies. At present he was compelled to allow for widely varying characteristics as to quality and size, while almost every appliance would burn fuel more efficiently and on a lower capital basis if it could be designed for a definite range.

He strongly urged that the National

Smoke Abatement Society should press for the more rapid replacement of old plant; a priority of some kind should be given to equipment which would reduce the smoke now produced.

C. M. Opie (Liverpool), said that the authors of the papers were to be congratulated for their valuable technical contributions to the conference.

From examination of a very large number of industrial coal-using plants, he had found that in the past industrial smoke emission had been closely allied with low efficiencies. It was probable that a large percentage of coal-fired boiler plants were operating with an efficiency of less than 50 per cent.; some of this loss was on account of conditions that were also favourable to excessive smoke emission. He would like to ask Mr. Hurley if it was possible for the smoke eliminators that had been developed at the Fuel Research Station to be made fully automatic in operation and not rely on attention by the firemen.

On account of fuel shortage for domestic purposes there had been such a clear atmosphere in many towns during the summer that visibility, normally only a few hundred yards had been increased to many miles. This had given rise to articles and letters in the press; and, he added, that it became news when atmospheric conditions approached the stage that should always be normal.

Mr. Edward had mentioned efficiencies in relation to the open domestic fire. When choosing a new domestic fire, the average housewife is mainly concerned with the appearance of the mantelpiece and tiled surround, the coal using equipment being looked upon as a necessary accessory that causes a great deal of dirt. Most housewives would be glad to see the new firegrates where part of the air supply for combustion could be brought from outside the room, where convectors could be fitted and the efficiency of the open fire at least doubled. Most of the local authorities in the Merseyside area had applied to the Ministry of Fuel to have a permanent Domestic Fuel Appliance exhibition in the area.

Mrs. J. Falconer (Electrical Association for Women) in reply to Mr. Opie, agreed that women looked at the mantelpiece in a room because they knew that it had to work in with their schemes of decoration, but they well knew the different types of grates and fires that could be put in the hole in the wall. She again attacked the men, especially in Scotland, for being at the back of all this conservatism. They were the stumbling blocks all the time. The Smoke Abatement Society must change its propaganda and be less gentlemanly. They must hit beneath the belt. The industrialist should be told of the real harm he is doing and make the housewife fully conscious of the fact that the smoke from her neighbours' chimney was slowly poisoning her child as it lay in its pram at her door.

Councillor James E. Ginty (Eston U.D.C.) said he would like to give a little constructive criticism to Mr. Edward's remarks. He contended that the design of the fireplaces in prefabricated bungalows created a smoke nuisance and that some method should be adopted so that only smokeless fuel was used. Councillor Ginty also said that he would like to support the very constructive suggestion of a private member who during a previous session said that a British Standard Specification should be laid down by the British Standards Institute for the manufacture of fireplaces.

W. Beaumont (Coventy) stressed the need for more active measures to be taken for the prevention of nuisances from Electricity Generating stations which arose from grit, sulphur dust and smoke. He thought that the Society should urge the Central Electricity Board to install in all undertakings modern plant for the prevention of atmospheric pollution. He also referred to a new type of chain grate for adaptation to shell-boilers designed for the burning of low graded coal without causing pollution of the atmosphere.

W. B. Kennedy (Manchester) said he was rather surprised that one very important statement in Mr. Hurley's paper had aroused no discussion. He referred to page 21, third paragraph, which read: "It will be observed that very little difference occurred in the CO_2 content of the flue gases over a wide range of smoke densities. A figure of 14 per cent., which corresponds to excellent combustion with a light smoke, was also obtainable with a black smoke, from which it is clear that a good CO_2 record chart is not necessarily a criterion of good operation." Mr. Kennedy thought this statement deserved the highest publicity both for the purposes of smoke abatement and fuel economy. Some boiler plant personnel had a CO_2 mania. No matter how dense the smoke emission might be, they insisted that

combustion conditions must be perfect if they were obtaining good CO_2 readings. They ignored the possible losses due to unconsumed CO, H_2, and CH_4. Some, in fact, disbelieved that dense smoke could possibly be emitted if the dampers were set to give a good CO_2 reading. Mr. Kennedy said that he was not, of course, decrying the use of CO_2 recorders, but was pointing out that Mr. Hurley's paper showed that the readings must be used with discretion. He said it was amusing the faith that some people placed in the infallibility of their instruments. He recalled, on one occasion, pointing out that certain boiler furnaces were being fired very inefficiently. The management proudly pointed to a newly-installed CO_2 recorder which gave a reading of 12 per cent., as a proof to the contrary. The firemen who had been listening to the argument, later said he was being paid a bonus on CO_2 readings and begged Mr. Kennedy not to refer to the CO_2 recorder again. The firemen had found out a method of opening the recorder, increasing the reading by six, thus satisfying the management and obtaining his bonus.

Mr. Kennedy noted that Dr. Meetham stated that for many purposes it was permissible to regard the suspended matter in the air as identical with true smoke emitted from chimneys and later stated that the simple smoke stain remained the most generally used device. He would like to ask Dr. Meetham if he considered that a local authority could obtain any real indication of smoke pollution in their area by the use of deposit gauges alone, or were not smoke filters necessary, in addition.

The Abolition of Domestic Smoke

Introductory Remarks by the Chairman

DR. R. VEITCH CLARK, M.A., B.Sc., M.B., Ch.B., D.P.H.

Formerly Medical Officer of Health, City of Manchester

I HAVE in the first place to express my great pleasure in occupying the chair at this conference of such a large and representative gathering of Local Government Authorities and of so many leaders in the domain of fuel- and power-producing plants. I have been in the innermost circles of the Society from its beginning and am glad now, from the relative quiet of retirement, to see the strength of performance it has attained and the promise of great accomplishments to come.

It is significant that the subject of our consideration should be discussed in Edinburgh—known the world over as "Auld Reekie." The soubriquet was given by Fife farmers who saw in the early morning when domestic fires were lit, the smoke cap appear over the City across the Firth. What a peculiar comment on human psychology it is that now the name should be one of affectionate memory.

That domestic smoke presents a problem of extreme complexity is admirably portrayed in the survey submitted by our indefatigable secretary—Mr. Marsh. I have no desire, nor indeed the ability, to anticipate the many speakers whom I shall introduce to the meeting, but there are certain general issues which I wish to raise and which I hope will receive—as they certainly merit—the attention of the society. I mention only two as it is inadvisable to overload suggested lines of action, but both of these are, I submit, fundamental. These are: (a) building byelaws should control the methods of heating buildings of all kinds just as accurately as they now provide for the control of ventilation (i.e. air-space) and light; (b) building byelaws should require dwelling houses to be insulated in the walls and roofs. This is recognized as a practical necessity in the economy of district heating of houses and if good or desirable in such schemes it is clearly a necessary economy for the conservation of heat and the consequent saving of fuel in all dwelling houses. Even a small percentage of saving in fuel per house would mean a very large economy in fuel consumption nationally.

I do not elaborate the case for these proposals but it is of note that public opinion is ripe for leadership in this direction as is evident for the formulation of smokeless zones in the cities of Manchester and London and in the fact that in new housing estates to a great extent only one open fire is provided per house. The experimental work now proceeding in the district heating of houses further shows the growing realization of the need for reform.

These two suggestions and all measures for the use of clean fuels and the saving of domestic labour appeal most strongly to women and offer a valuable field to public-spirited women for a real contribution to national health and well-being.

Lastly, let us always bear in mind the underlying principles of smoke abatement—health, cleanliness and the innate love of man for beauty and light. Our great national literature teems with references to beauty of light and the horror of gloom. All show the fundamental longing in man for beauty and freshness in life. Follow this as our beacon. Courage to go forward is based upon hope of achievement and hope of achievement must always rest upon belief in the practicability of our desires. That is what this conference is met to consider and why this Society exists.

Opening Survey and Questions

By ARNOLD MARSH, M.Sc.Tech., M.Inst.F.,

General Secretary.

THE purpose of this survey is unusual. It is not, in the main, to state a programme or to propound opinions, but simply to ask questions. It is a frame to be filled, it is hoped, by the contributions of those who will follow. This procedure has seemed necessary if we are to have a constructive and unified discussion that will help us to see the pattern for future progress in the abolition of domestic smoke. (The questions, it will be noted, have been numbered to make it easier to refer to them in the discussion.)

Negatively, our problem is simple. It is completely to discontinue the use of raw bituminous coal for all domestic purposes, and to use in its place any of the alternatives, all of which for present practical purposes may be regarded as smokeless. Positively, we are at once faced with more difficult questions. We know what the alternatives are, but can they in fact oust raw coal completely ? (1). Are the public prepared to accept them ? (2). To what extent, and when, can they be made fully available for all requirements ? (3). And how much can and should be allotted to each of the different alternatives ? (4).

These are the problems we wish to examine, and perhaps it will be easiest to start with the principal object of our concern, the open fire. (The term open fire in this paper will include combination ranges, etc.).

If we could abolish the open coal fire in the near future, the problem would be solved, but it has to be recognised that a very considerable attachment for this traditional method persists—the growing offensive against it has not yet penetrated to any great depth. A recent Gallup Poll revealed that 68 per cent. of the population still preferred it to other forms of heating. Further, as will be discussed later, there is no early likelihood on technical grounds of it being possible, in the next few decades, to do away with solid fuel in the home, although, quite apart from smoke prevention, it may be essential to allow it to be used only in appliances of maximum efficiency.

Assuming therefore that the plan we need must include the improved open fire, and the closed or the openable stove the question is what can be done to make them smokeless ? (5). The old-fashioned fire must go not only because it is so inefficient, but because it is not suitable for all forms of smokeless fuel, and we now have improved types at once more efficient and able to burn all kinds of solid fuel. These are still in very short supply, though the Ministry of Fuel has estimated that by the end of this year, 50 per cent. of total production will be of these improved types. When, we must ask, will the output reach 100 per cent. ? (6). When will it be possible to urge the Government to prohibit any further manufacture of the types now obsolete ? (7). Further, what of price and quality ; can we count on the change-over we want being eased by any reduction in price as mass production or other factors come more fully into play ? (8). And can we expect any further improvements in design or performance ? (9).

From the smoke abatement point of view it does not matter whether the simple multi-fuel fire, the convector fire, the continuous-burning fire, the closed or the openable stove is used. But from the viewpoint of efficiency and fuel conservation there are considerable differences. What are the prospects for popularizing the more efficient stoves ? (10). Again, the Society has proposed that inefficient grates and ranges in existing houses should, when conditions permit, be replaced by the new types or by other smokeless appliances. This has also been proposed in the Simon Report.

We know that this can be done only by stages, for which the Society's scheme of smokeless zones can be used. But when can this be started, and how fast can it proceed, bearing in mind that the new housing must obviously have first priority? (11).

Smokeless Fuels

The improved appliances just referred to can burn bituminous coal, and their rapid installation will materially help the drive for fuel economy. But they should be allowed to use such coal only until there is sufficient smokeless fuel available. Then, again stage by stage through smokeless zones, the use of these fuels can be made obligatory. The solid smokeless fuels include the Welsh anthracites and other natural smokeless coals (and also, it should be added, some natural smokeless coal from Scotland), and carbonized fuels from gas works, coke ovens and low temperature carbonization processes. A steadily increasing production of these fuels is called for, and the Simon Report considers that it will take 20 to 30 years to complete the change. We believe that if the necessary effort is made (and the fuel situation may well give it higher priority than we could otherwise have hoped for) it can be done in much less time; perhaps in ten years. Is this a reasonable hope? (12). What increase in production of these fuels is technically possible, and can therefore be pressed for by the Society? (13). How much can the Welsh output (for the *home* market) be expanded? (14). How much more gas coke can we expect, and to what extent does this depend on a parallel increase in the use of gas? (15). And can the coke-ovens produce and guarantee a substantial production of a coke burning freely enough for all domestic appliances? (16). What developments in low temperature carbonization can we hope for? (17).

This last process normally produces a fuel suitable not only for the new types of grate and stove, but also for the old-fashioned grates in which less reactive fuels are not so suitable, and can therefore be used where these have not been replaced. But gas cokes and perhaps even oven cokes can be so modified by blending or changes in carbonization technique that they too can be made to burn as freely as bituminous coal. Given the improved appliances this may not be essential, but at least for some time to come it would be advantageous to have such fuels in good supply. What is the policy of the carbonizing industries in regard to this? (18). What can we hope for, and what quantities of what qualities of coke are possible? (19).

To achieve popularity the solid smokeless fuels must be as free from ash as possible. This has always been a problem, and conditions have of course seriously deteriorated in recent years as a result of the poorer quality coal available. But it is not only ash; coke is very variable in ignitability and reactivity, and some samples are much better than others, even on the improved fires. A standardization of quality at a higher level is looked forward to when conditions permit, and some light on these important technical questions would be valued. The question of price, too, is important. The establishment of smokeless gases and prohibition of raw coal can be effected with justice and general public agreement if the new fuels are no more expensive—*and seem to be no more expensive*—than the raw coal they displace. It is not a laboratory equation that is called for, but a comparison that will be understood and appreciated by the housewife in terms of cash and quality when she pays for her weekly hundredweight. What is the position, (20) and what can the Society tell the public in its educational propaganda? (21).

Central Heating

The higher standards of heat comfort and efficiency so glaringly needed in this country require the warming of the whole house rather than of single rooms. This can be done in the first instance by central heating provided by an individual boiler in each house. When this is done, open fires can be abolished or used only for emergency purposes. Such boilers normally use smokeless fuel. After a long failure to gain popularity the idea of central heating for the small house appears at last to be making headway. Discussion would be useful on what actual progress may be expected, not only in new houses, but even in existing houses. The capital cost of installation, especially in the latter case, appears to be the chief obstacle, but is it insuperable? (22). Is there a sound case for advocating installations in either new, or in both new and existing houses, on a large scale, so that costs may be brought down to a level that, when balanced against resultant fuel savings, will commend the method to all concerned with housing? (23).

Central Services

From the individual fuel-burning installation we may pass on to the services provided on a community basis from a central service. Gas and electricity are the familiar central utility services and the developing system of district heating should be placed in the same category. All three services are smokeless and it is in one sense, immaterial to the Society how they share out the job we wish them to do. For many reasons the evolution of domestic heating is likely to be towards the complete supply of energy (electricity, gas or district heat) from a central source of supply, where it can be produced under conditions of maximum efficiency, and away from the individual heat-generating plant dependent on solid fuel. This evolution will take a considerable time before it is completed, but if it is technically desirable, will promote coal conservation and provide better and more economical heating in the home, it should be speeded up. It can then play an important part in the abolition of smoke by sharing the load that will otherwise have to be taken—with perhaps much strain—by the solid smokeless fuels.

While the central services are already doing much, and can do still more, to increase heat comfort in the home, from our point of view they are only making a substantial contribution to smoke prevention if they are actually displacing raw coal. For example, gas or electric fires in bedrooms only assist smoke prevention when the alternative is a raw coal fire *in use*—which is not often. Or if the district heating should be "topped up" in the living-room with a coal fire "for comfort," it will give a home warmer than those we have now, but not less smoke. What we wish to know therefore, is not to what extent the three central services can meet secondary needs, but how far they can go in solving our major problem, the coal fire in the living-room? (24).

First we may consider the established services, electricity and gas. Both have made great contributions to the comfort and cleanliness of our homes, and although to some extent this has been for intermittent and auxiliary heating, there is no doubt that they have also substantially reduced the number of coal fires in use, and have also very largely solved for us the problem of smoke from cooking ranges. What can we expect from them in the future, both in new houses and in the extension of their use in existing houses? (25). What progress do the two industries foresee, and what conditions do they ask for to make this progress certain? (26). What can be done to make it economical for the ordinary householder to use gas and electricity in place of coal—that means what are the possibilities of reducing the price of these mediums to a level competitive with solid fuel for continuous use? (27). What are the general lines of advance, both in production and utilisation? (28). And are there any technical developments of importance in the offing? (29).

In respect of gas, is the complete gasification of coal likely to develop in the next decade or so, in such a way as to change the domestic supply position? (30). Or does the future seem to call for a balanced consumption of gas and of coke to secure the best economy? (31). To secure the increased output of solid smokeless fuel already discussed there will have to be a large expansion of carbonization capacity. How rapidly can this be done? (32). What is needed to ensure progress at a satisfactory pace? (33). Also we might ask about the need and prospects of a gas grid, and whether there is a call for some co-ordination or integration with the coke-oven industry? (34).

And then electricity. A recent report gave the impression that electricity could and that the industry wished to take the whole of the domestic heating load, open fires and all. If this is the case, the problem is greatly simplified, but may we ask if we can have the statistics of the case put to us? (35). The economics of electricity utilisation for domestic heating are greatly strengthened, it will doubtless be argued, if generation can be linked with district heating, or if we can use it in conjunction with the heat pump or a reverse cycle heating and cooling (and air conditioning) appliance—a development already on the market in the U.S.A. What are the views of the industry on such matters which appear to have great potentialities for the future? (36). And can any other radical changes be forecast, apart from the looming but still unpredictable use of nuclear energy for electricity generation? (37).

About district heating we could put many questions, for this is an infant of great interest, but they can more certainly be answered by waiting to see the working results and users' reactions from the first installations now coming into being.

If the reports are good, then there is no doubt that district heating will be widely extended. If any are disappointing for any reason, further experiments on different lines may be tried. Theoretically, the thermal-electric system appears to be preferable, having regard to both products of the process, electricity and district heat in the form of hot water or steam. But this can be economically applied, it would seem, only to new generating plant designed for the purpose. To what extent is this to be done with the new power stations we are promised? (38). Or we are to rely predominantly on the straight thermal system, in which district heat is the only product? (39). Have the services already being planned, and in some cases already being operated, suggested any new possibilities? (40). Again, there must obviously be a limit to the scope of district heating—lack of building density, for instance—but where that limit lies does not yet seem to be clear. How far can district heating go, and remain a paying proposition? (41).

There are other questions that may not so directly concern smoke abatement, but which are indirectly important, as they affect the general pattern that, because of other factors, smoke abatement must take. Chief among them is that of securing the conditions of production, distribution and load most advantageous for each of the central services. Is the full attainment of these conditions possible for each? (42). Or is it only possible to secure the best conditions for any one at the expense of the others? (43). If the latter, then it becomes necessary to determine and maintain some pattern of development that, although it may not be the ideal of each of the industries, will give the most general all-round advantages to the consumer and to the community. This is a question to which perhaps a complete and impartial answer can be given only in a scientifically conceived, long-term national fuel policy, but, for the moment, it would be of interest to hear the views of the three central services—and also from those concerned with solid fuels.

It would be possible to continue and to elaborate this survey, but already 40 questions have been asked, and in the discussion that will follow there will doubtless be more. Perhaps, therefore, there is a fair amount of scope for those who have kindly agreed to answer them.

Replies to the Opening Survey

(1) Gas

By D. C. CROSS, M.Inst.C.E.
National Gas Council

THE National Smoke Abatement Society has asked each of the Fuel Industries a number of searching questions on their future policy, and what help and co-operation can be expected towards the pressing problem of prevention of domestic smoke.

It would have been easier to have given answers in 1938, but under post-war conditions the Gas Industry as a whole is not free to control its future policy, and dependent as it is upon coal, the Industry has had to temporarily suspend many of its progressive expansion plans, and submit to an emergency policy dictated by the Government to meet the expediences of the fuel crisis of the past twelve months.

Therefore the following opinions are given on the assumption that the Gas Industry will in the near future be given more freedom to expand on rationalized grounds unhampered by political uncertainty.

The first important general question is whether the public are prepared to accept completely the use of smokeless fuel in place of raw coal. Without hesitation, I would answer Yes, subject to the following qualifications:

(1) That the public shall be fully educated and convinced from the highest level that coal is the life blood of our nation, and that it is imperative to make the fullest use of every ton of coal mined and its bye-products.

(2) That it is as much a national crime to waste coal and burn it wastefully in its raw state in inefficient grates, as it is to waste valuable food. The public have

been educated and convinced in the past of the necessity to spend vast sums of money upon health services for the prevention and cure of disease and illness, and I feel sure the public would equally respond if the following advantages were as clearly and emphatically pressed home (a) benefit to health from more sunshine through the elimination of smoke; (b) increase in vegetation, when we are so dependent upon home produce; (c) an appreciable saving in the upkeep of buildings.

I would point out that at one time in England, householders threw refuse into the roads to the detriment of their neighbours, as freely as they now pour smoke into the surrounding atmosphere, and this nuisance has been abated despite the cost of the installation of sanitation.

(3) That sufficient smokeless fuel is available without the necessity for the public having to queue for it, or for restrictions upon its use.

(4) That some Government pressure should be exercised to compel property owners to scrap obsolete, inefficient and wasteful fuel burning appliances, and install modern efficient appliances as they become available. If landlords are compelled to meet the expense of improving their fuel-burning appliances in existing buildings, it may be necessary to give them some redress, but I am not convinced on this point because in like manner, if the sanitation of a house became defective and a public nuisance to the neighbours, the property owner would be compelled to take all the necessary steps to stop the nuisance at his own expense.

The next question—when can smokeless fuels be made fully available for all requirements, is I am afraid, with the present economic condition of the country, impossible to answer. Normal expansion of the smokeless fuel industries for the home market must naturally be influenced by the necessity for first priorities for agricultural, mining and export industries, and be affected by shortage of material and delay in obtaining machinery. But knowing the extensive programme of reconstructon and extensions in hand, I am confident that the Gas Industry will be able to meet all the increased demands for gas and coke which will arise from the normal evolution of public opinion to the ultimate goal of complete abolition of domestic smoke.

While I am confident that the Gas Industry will eventually meet all increased demands for gas, there is bound to be a transitional delay before there can be a really substantial increase in the quantity of coke available for sale. The normal expansion and reconstruction of carbonizing plant had to be curtailed during the war years, and it will be several years before the industry can overtake arrears, especially when it is realised that no new carbonizing plant can be built under 3 years.

Mr. Marsh has touched upon a vital point when he asks when will it be possible to urge the Government to prohibit any further manufacture of types of open-fire grates which are now obsolete. Surely there is no time more opportune than the present. The nation is desparately short of coal; therefore, it is only common sense that the installation of old-fashioned, inefficient and wasteful grates in new houses should be prohibited at once.

During the war, if a weapon became obsolete, its manufacture was stopped at once and a concerted drive was made to manufacture large quantities of new weapons to take its place. Why not use the same drive now to save wasteful burning of coal, while we are engaged in another Battle of Britain! The improved efficiency of fuel-burning appliances will bring an eventual saving both to the householder and to the nation.

The same remarks can apply to old gas fires. There are many obsolete gas fires in use which are over 25 years old, which if replaced by a modern efficient gas fire or convector fire, would show an immediate saving in gas of at least 50 per cent. and in some cases up to 100 per cent. with the same output of heat. The capital outlay for the new fire would soon be recovered by the saving of gas which in turn would mean a saving in coal used to make the gas.

Smokeless Fuel

Mr. Marsh has asked whether complete gasification of coal is likely to develop or whether a balanced consumption of gas and coke will secure the best economy?—and how much more gas coke can we expect in the next ten years?

The future policy of the Gas Industry has been somewhat confused by the emergency through which the country has passed in the last two years.

The reason for the present shortage of coke is that the Gas Industry, for the last 18 months, was instructed to make as much gas as possible by complete

gasification in order to save coal, and many gas undertakings have been forced to install plant-making gas out of coke and oil in order to meet the demand. In June of this year the Government reversed its policy and now the industry is instructed to make as much coke as possible and use a minimum of oil. Naturally, it will take some little time to adjust our manufacturing plant, as new carbonizing plant cannot be erected under 3 years.

It can be confidently assumed that a considerable increase in supply of coke will be available for the domestic market when existing retort houses have been reconstructed and new plant installed, but the increased quantity of coke available will depend to a great extent on a parallel increase in the use of gas.

The Gas Industry has little control over the quality of the coke supplied to the public, as it is almost completely dependent upon the quality of the coal supplied. In pre-war years when gas undertakings had freedom in the purchase of coal, the quality of coke sold to the public could be controlled and guaranteed.

The tendency of the Gas Industry is towards carbonizing in vertical retorts or chambers. The effect will be to help gas in maintaining a cheaper relative value to the cost of other smokeless fuels. I can only give figures for the Gas Company with which I am associated in the London area. In the last 8 years the price of coal to the Company has increased by 111.5 per cent., whereas the price of gas has increased by only 37.7 per cent. and the increase in price of gas for the whole London area is 52.7 per cent. in the same period.

Mr. Marsh has asked whether the housewife will find it more expensive to displace raw coal by smokeless fuel. Coke used in a suitable appliance will certainly be no more expensive than coal for space heating or water heating, and will probably show economies, but when considering substitution by gas for cooking, water heating, and intermittent space heating, it is not strictly correct to compare the net cost of gas with the net cost of raw coal. There is an intrinsic value to the housewife in the saving of labour, the cleanliness in the use of gas, the convenience of the fuel being on tap for use at any moment, and the real saving of waste when gas can be shut off immediately it is not required.

Another benefit which it is difficult to assess in cash is the saving in washing, decorations, health and increased vegetation, as smoke in the atmosphere becomes eliminated.

Central Heating

Central heating is an ideal method of heating houses and large buildings as practised on the Continent and in Canada, but it must be recognized that for the added comfort it will be more expensive than our present method of heating individual rooms, especially in the old existing houses where no attempt has been made to insulate the walls and roof. In Canada where central heating is popular, the walls and roofs are built to conserve the heat, and double glass windows are fitted. Coke is the ideal and most economical fuel for central heating, but for comfort and efficiency the coke-burning appliance should be thermostatically controlled. This is quite a simple matter for large buildings and institutions, but it is not so easy for small buildings. I would not advocate gas for central heating or for heating a room continuously all day.

Mr. Marsh asked to what extent can the central services, Gas and Electricity. contribute in the future to the displacement of the burning of raw coal for the prevention of smoke and in solving what he calls the " major problem " of the open coal fire in the living room. For the householder who requires an open fire burning in a room for any length of time, I suggest, from personal experience, than an open coke fire burnt in a grate designed for coke, will give all the comfort of an open coal fire without any extra expense, except the initial installation cost of a coke grate, with the added convenience of gas ignition which allows the householder to let the fire die out when the room is not in use, knowing that it can be quickly re-ignited as required.

This statement may be challenged by pointing out the present scarcity of supply of modern coke grates and coke. Granted, there is an existing shortage mainly due to post-war conditions, but we are thinking of the future when building has picked up its arrears and supplies of appliances are more normal again. The Gas Industry should be able to take a considerable share in the change-over to the use of smokeless fuel and elimination of smoke.

Gas is an ideal smokeless service for cooking, water heating, refrigeration and quick intermittent space heating or for secondary " topping up " where district

heating or other central heating is in use. Its chief merit is that it is on tap, and can be brought into use immediately at full capacity whenever needed and shut off the instant it is not required.

Each service has its own advantage in certain domestic uses and should be developed fully to create a correct balance among all fuel services for the ultimate benefit of the public.

I would like to emphasize that when planning for the future fuel service for the public, we must endeavour to avoid bottlenecks and the overloading of any one particular service which only creates unnecessary hardship and inconvenience. A service should not take on additional loads beyond its capacity to produce or supply until it can assure the full continuous requirements of its existing load. This remark applies equally to gas, electricity, coke and smokeless coal.

All fuel services should be administered to give the maximum efficient service to the public with the minimum use of coal, and be outside any form of political propaganda and political expediency.

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Electricity

By V. W. DALE

British Electrical Development Association

THERE appears to be a tendency today in some quarters to regard electric heating as being almost heretical. One speaker at the not-so-far distant Fuel and the Future Conference in London, even went so far as to refer to —" that absurdity, the all-electric house." Surely this shows a lamentable lack of proportion; we must not fall into the error of saying the grapes are sour because, for one reason or another, we lack the courage to admit that they are desirable but unfortunately out of reach.

There is nothing basically wrong, there is nothing whatever to be ashamed of in electric heating. Owing to unfortunate legacies of the war it is, and may well be for a long time, out of reach of many of us, but nevertheless it is still an eminently desirable form of heating in every respect. Before the war it may have been too dear for some people, today it is too scarce, but in our planning we must not forget tomorrow.

At the present moment it is miner-hours that are all-important, and for our continued existence it is expedient and necessary to expend two or more man or woman-hours in the form of housework, fuel transport, and redecoration (if we were allowed to do it) and so on, to save one miner's hour, but ultimately it is man-hours that matter, and to spend two man-hours to save one is an expedient, and not a policy that is likely to lead to prosperity. If any lesson can be learned from the present situation it is not that electricity should not be used for heating at all, but that for the time being it should only be used where its many virtues make it particularly suitable and economical.

It has been asked whether the Electric Supply Industry wishes to take the whole of the domestic heating load, and to this question it is scarcely possible to give an entirely unequivocal answer. Today, and possibly for some little time, the answer must inevitably be "no"; shortage of generating capacity makes this imperative, but what will be possible tomorrow is a very different question.

If all the homes in the country were constructed with a view to the conservation of heat it would be possible for them to be heated electrically under present generating conditions without any increase in the amount of fuel that is used for domestic heating.

It is asked what can be done to make electric heating economic for the householder. There is more than a hint at the present time from the householder himself that electric heating is perhaps too economic, and in any case, the implication that electric heating *must* compare on fuel costs with solid fuel is patently absurd. Why should electric heating always compete on fuel cost with solid fuel? One doesn't expect the cost of whisky or beer to compare with that of water. Electricity and solid fuel are not precisely similar things; electricity is a service, and incidentally, it is the only one service that can supply all the light,

heat and power needs of the modern household.

Much has been made of the alleged affection of the British public for the open-fire, but whatever we older members of the community may think we must not forget that it is the growing generation that counts. Our sentimental regard for the open-fire is not necessarily passed on to our children and opinion polls may be misleading. Who would have prophesied a short time ago that electric cooking, for instance, would be as popular as it is today? It is more than likely that what is termed the sentimental regard for the open-fire is not really sentiment, but a desire for high temperature radiant heating. There is very general agreement today that maximum comfort is achieved with high temperature radiant heating, providing that the air temperature is not too low. It is at least possible that a large section of the public are quite willing to exchange the open-fire for the high temperature radiant heat from an electric fire, although they are not willing to forego their open-fire for the dubious delights of central heating.

Great emphasis is laid upon the contribution that smokeless fuels make towards smoke abatement, but though it may be a little unkind it is only fair to point out that though these fuels may be smokeless they are not fumeless and they are not dustless, coke being a particularly bad offender in this respect. A large part of our lives is inevitably spent indoors, where it must be our aim to secure atmosphere no less pure than in the open spaces.

Another question asked in the opening address is whether we can expect improvements in design of smokeless grates, stoves, and so on. One sincerely hopes that improvement can be expected because the performance and appearance of some of them certainly appear to leave much room for improvement, but another question that might have been put is "What will the performance of these appliances be after years of use?" It is no good building too much upon the performance of brand new equipment; that has already been discovered by other fuel interests.

So far as the combination of district heating with generation of electricity is concerned, there is little doubt that the most efficient system will be found to be that in which electricity is the by-product and heating the main product. It is notoriously unsafe to prophesy, but were the gas turbine adopted for generation on a large scale it would completely alter the prospects of supplying heating from the waste heat, owing to the fact that waste heat from a gas turbine is at a much higher temperature than the waste heat from steam plant.

One question that has not been asked is whether district heating schemes are going to be designed to stand on their own feet and to be capable of coping with the worst our climate can produce, or are they to follow in practice the dangerous gospel that is being preached of relying on electricity or gas to come to their aid. There can be few reports on projected district heating schemes in which the viciously short-sighted phrase "In extremely cold weather gas or electric fires will be used" does not appear.

There are also possibilities in connection with the heat pump and when the refrigerated larder replaces the refrigerated cabinet and "deep freeze" storage space is a feature of every household it may well be possible to use the heat pump in domestic heating.

None will dispute that in the general adoption of electric methods—for heating for all forms of industry, for railways, etc., lies a solution to smoke abatement—as complete as we are capable of grasping at the present time.

Central and District Heating

By DONALD V. H. SMITH, M.I.E.S., M.I.H.V.E., M.Inst.F.

I AM asked to deal with Central and District Heating.

I welcome the opening paper—if you get some precise answers you will have the factual data to work on.

Laws or regulations alone are not enough, they are indeed useless, unless economic.

Manchester over 100 years ago had severe clauses in their by-laws prohibiting smoke. Long before that, it was a crime punishable by hanging, to

burn raw coal. All to no effect on the real problem. It must be attacked from the economic side.

Here, therefore, are my comments and answers to the various queries as they relate to Central or District Heating.

Question 22. Capital Costs

These should never be considered a barrier to improvement before calculating the resultant annual operating costs. On a new house, the capital cost of Central Heating is very little higher than the provision of a number of fireplaces and flues. The *extra* cost might be as low as £20 or £30 and should not exceed £50 or £60 on a four or five-roomed house.

On a district system the extra cost might be from £80 to £120 per house on a new estate (this largely depending on number of other buildings, viz. public and commercial, brought into the scheme, on each of which a boiler house, fuel store and chimney stack would be saved).

The operating costs in each case allowing for fuel, labour, maintenance and capital charges including repayment on any reasonable period, should in most cases show a reduction on yearly costs as compared with any other method.

The result should be a smokeless area.

On existing houses the capital cost will obviously be higher since capital has already been spent on stoves, fire-places or flues, much of which could be saved when building anew. The saving in fuel is, however, considerable, and that plus saving in labour warrants serious consideration when modernizing old houses, though the relative advantage and costs of the newer types of stoves and/or fires should then be also weighed.

Question 24

Paragraph 12 suggests that District Heating, if restricted to require topping up by a coal fire in the living room, will give a warmer home, but not less smoke—that is surely erroneous. If District Heating or Central Heating is laid on and the house is warm, the living room being also partially warmed from the same source, the reduction in the amount of coal used would be substantial. On mild days the open-fire would seldom be lit, even on colder days the tendency would be to restrict its use until evening or perhaps only at week-ends, and when lit a much smaller fire would be needed. If 80 per cent. or 90 per cent. of the heat required is obtained by smokeless central heat, then 80 per cent. or 90 per cent. of the aims of the Society would be achieved.

Many households would soon put in a gas fire in the fire-place for the small amount of topping-up required, rather than be bothered with coal, ashes and dust, and so achieve complete smokelessness.

Question 25

In my opinion it is impossible to expect electricity to solve the problem on present methods, it is too costly a medium and too wasteful of coal. It uses even more coal than a well-designed plain brick open fire-place.

Electricity may be more economical and advantageously used in any district where combined thermal electric schemes are installed as on such stations it would be a cheap by-product of the main heat system and it might be desirable on such stations to actually increase the electric load. At present, on condensing stations, it is unfortunately necessary to restrict the use of electricity, and it is no use shutting the factories in order to keep us in idle comfort at home.

Even when the existing generating stations are extended, electricity from condensing stations is too costly a medium for space heating in any large scale. (See also answer to Question 35).

Question 31

There is a wide and useful sphere for gas for use in replacing old fire-places in existing houses where it is uneconomic to instal Central Heating, and on new estates where it can be used for topping-up District Heating schemes.

The conversion of many existing houses to Central Heating will also add to the demand for coke, and between these three new spheres for the gas industry there is likely to be a demand for gas and gas products which it will take the industry all its time and energies to meet.

Question 35

To suggest that electricity could take the whole of the domestic heating load is sheer nonsense, and would be very bad economics.

For space and water heating alone, allowing a modest total of 300 therms per year per house, the 11 million existing houses would require nearly one hundred thousand million units, the additional four million houses which all parties agree are needed, would require

a further thirty-five thousand million units, but the present standards of heating are admittedly too low, and if the old houses are left on the lower scale and the new ones only raised to say 450 therms per year (an amount still low according to some authorities), then the total electricity required would be over 150 thousand million units per year.

You have still to cater for the lighting and industrial load, and when you recollect that our *total* electricity production in one year is in the region of only 40 thousand million units, and the power companies are strained to produce even that, surely further comment on the notion of all-electric houses is superfluous.

Even in small numbers, every all-electric house (except where supplied from a thermal electric station as suggested in the reply to question 25) only adds to the shortage of electricity for manufacturing purposes.

Electricity should be used for light and for power, its use for space heating should be regarded as a luxury, or reserved for very occasional and intermittent emergencies only, or for areas where other alternatives do not exist. Even in wealthy America electricity is little used for space heating because they cannot afford it, and neither can we.

Question 36

If electricity is generated as a by-product of District Heat, then there is a case to be made for a somewhat wider use of electricity in topping-up, but it should be clearly understood that such projected stations, even if constructed and developed to their maximum possibility in Great Britain, can only be *secondary* stations, and the main supply of electricity must come from the existing stations and those new condensing stations under construction or projected.

Question 37

District Heating has been used for many years in U.S.A. and on the Continent of Europe. Its economy, if well designed on suitable estates, is incontestable. It is cheaper in running cost and in the amount of coal used, than any other method so far produced.

Thermal electric systems will not necessarily provide cheaper heat; it is on electricity as a by-product that the main reduction in costs is secured, not on the heat side.

Existing generating stations cannot economically supply heat from so-called "waste heat." The generating plant must be specially designed, and this can only be done on a large scale where such a station can be located in or near to a new town or a reconstructed town.

Small purely thermal stations to serve new areas can be economic for as few as 200 or 300 houses at densities of between 10 and 20 per acre. In size and area I know of precise limit, anything between 200 houses and 20,000 houses can be served from a single plant. If public buildings or small industrial areas also are served, the economies both in £ s. d. and in fuel, can be startling. It can safely be said anything from a small village to a medium-size town can be served economically, *but they must be planned in advance.* On costs, the tables attached will give some idea of the operating costs as compared with other methods. These tables are all based on present-day costs and on schemes either actually under construction or in preparation.

Comparative figures are also given for heating by other methods on today's basis of costs.

I have dealt with seven of your questions, as precisely and objectively as possible, but will be pleased to reply to any queries.

Total Costs including Capital Charges of supplying by various methods 500 *useful therms per annum for space and water heating to Dwelling Houses.*

Basic fuel costs assumed :

Electricity ¾d. per unit.
Gas 1s. per therm.
Household coal 80s. per ton
Coke 80s. ,,
Low grade coal 50s. ,,

The capital charges shown in the following items include for the cost of all internal works necessary in each case, i.e. fireplaces, flues, electric fires, gas fires and vents, water heaters, boilers and radiators as required to suit each stated case.

Items 6 to 8 include Hot Water Service from a central station, as well as for the heat supply for space heating and alternative methods of topping up.

1. All Electric	£	s.	d.
14650 units	45	15	8
Capital charges 7½% on £60	4	10	0
Total	£50	5	8
Cost per therm in pence			24.14

2. All Gas

666 therms gross	33	6	0
Capital charges 7½% on £60	4	10	0
Total	£37	16	0
Cost per therm in pence	18.14		

3. Coal Fires and Coke Boiler for Hot Water

5 tons coal	20	0	0
2.1 tons coke	8	8	0
Capital charges 7½% on £60	4	10	0
Total	£32	18	0
Cost per therm in pence	15.79		

4. Combination grate with back boiler for Hot Water Service and Warm Air ducts to upper rooms

5.6 tons coal	22	8	0
Capital charges 7½% on £100	7	10	0
Toɔal	£29	18	0
Cost per therm in pence	14.35		

5. Central Heat and Hot Water Service, with gas fires for topping up

4 tons coke	16	0	0
90 therms gas	4	10	0
Capital charges 7½% on £110	8	5	0
Total	£28	15	0
Cost per therm in pence	13.8		

6. District Heating and Hot Water Supply, with electric fires for topping up

425 therms from District System @ 6s. 6d. per week	16	18	0
2198 units electricity ...	6	17	2
Capital charges 7½% on £40	3	0	0
Total	£26	15	2
Cost per therm in pence	12.84		

7. District Heat and Hot Water Service, with gas fires for topping up

425 therms from District System @ 6s. 6d. per week	16	18	0
75 therms gas (112.5 therms gross)	5	12	6
Capital charges 7½% on £40	3	0	0
Total	£25	10	6
Cost per therm in pence	12.25		

8. District Heat and Hot Water Service, with coal fires for topping up

450 therms from District System @ 6s. 6d. per week	16	18	0
50 therms from ¾ ton coal	3	0	0
Capital charges 7½% on £70	5	5	0
Total	£25	3	0
Cost per therm in pence	12.07		

9. All District Heating and Hot Water Service (no topping up

500 therms from District System	18	2	0
Capital charges 7½% on £60	4	10	0
Total	£22	12	0
Cost per therm in pence	10.4		

Note: on items 6, 7, 8 and 9

The costs for District Heating have been taken from a number of schemes recently designed, some of these being actually lower in cost than the figures stated above.

With a well-designed system on a favourable layout embracing Dwellings, Public Buildings and Industry, the cost would be substantially less.

B42

Solid Fuel Appliances

By Dr. W. DAVIDSON,

(Radiation Ltd.)

THERE is no single or immediate solution to the great problem of abolishing domestic smoke and it is necessary to consider not only a variety of remedies, but both a short and a long term programme of attack. The increased use of gas, electricity and the solid smokeless fuels has greatly reduced the domestic smoke nuisance and whilst the contribution made by each will continue to increase, after the present difficult conditions pass, it will be a very

long time before they could satisfy the whole of the domestic heating and cooking load. District heating may also play an important part in reducing domestic smoke but its adoption on a appreciable scale will depend on the success of the schemes now going forward and must therefore be slow. Bituminous coal burned in individual appliances must, therefore, continue to supply for many years, the major part of the domestic heat services and especially the space and water heating load. We must therefore look to the solid fuel appliance to make the greatest immediate contribution towards domestic smoke reduction.

As Mr. Marsh has pointed out in his opening address, the open coal fire is chiefly responsible for the domestic smoke problem and is, moreover, very inefficient. Mr. Marsh advocates the substitution of the open coal fire by the smokeless fuel grate, the open convector fire or the openable slow combustion stove in existing houses as well as in new housing. For some years now makers have been encouraged to produce appliances suitable for burning smokeless fuels in addition to bituminous coal, so that the greatest possible use could be made of the smokeless fuels which were available for the domestic market. Such large numbers of these appliances have now been installed that the demand for smokeless fuels far exceeds the supply. This policy of producing smokeless fuel appliances is justified by the greatly increased efficiencies obtained when using these fuels and the fact that when burning bituminous coal the efficiencies and performances obtained are at least equal to and often better than those given by the alternative bituminous coal burning appliances. The fact, however, remains that the smokeless fuels give so much better results than bituminous coal when burned in these new appliances that when a user has experienced the advantages of the former he is dissatisfied with the latter fuel. Their efforts to obtain smokeless fuels has often caused much embarrassment to the Ministry of Fuel and Power.

While the continued production of smokeless fuel domestic space, water heating and cooking appliances capable of burning bituminous coal satisfactorily should be advocated, it is of the utmost importance that makers should, without delay, concentrate their researches on the development of appliances for burning bituminous coal with the minimum smoke emission and the maximum efficiency, which will also be capable of burning the smokeless fuels with the same or higher efficiencies than the best present-day types. This is no doubt a most difficult task but no other approach promises to make such a great contribution towards smoke abatement and fuel conservation during the next ten years.

It is suggested, therefore, that the smokeless fuel appliances capable of burning bituminous coal should be regarded as the half-way stage between the pre-war designs of coal burning appliances and the future types which will burn coal smokelessly and efficiently. To say this is not to underrate the very considerable advances which attended the introduction of the smokeless fuel appliances and it will be useful to consider these briefly.

The Open Coal Fire

Pre-war types of open coal fire gave efficiencies of 15-23% and gave off as smoke and soot 2-6% by weight of the coal burned.

The Open Smokeless Fuel Grate

A variety of new designs of this type of grate has been marketed during the last three or four years. The best of these give the following radiant efficiencies for the given fuels :—

Gas Coke	33%
Low temperature coke ...	28%
Anthracite	28%
Steam Coal	27%
Bituminous Coal ...	25%

In the case of two or three of these grates, a special brick set, the back member of which overhangs the fire, is provided and this is partly responsible for reducing the smoke emission when using bituminous coal to 1 to 1½% by weight of the fuel burned. These grates are very convenient in use, gas ignition being provided while an effective air control allows the output to be varied between 4,000 B.Th.U./hr. and 15,000 B.Th.U./hr. (16 in. fire). A few models provide overnight burning at rates of approximately ½ lb./hr.

The Open Convector Fire

The open convector fire is proving to be a most popular appliance especially with those who wish to retain the attractive appearance of the conventional open fire. Modelled on the open smokeless fuel grate it possesses the advantages

noted for this type of grate and in addition gives much higher efficiencies, the overall efficiency using coke being 50% and coal 35%. When a back boiler is fitted the efficiency is increased to 55% for coke and 44% for coal. The increase of 10-20 units over the efficiencies obtained for the non-convector grates is given in the form of warm air which may be vented into the same room as the fire is installed, thus reducing the fuel required, or it may be ducted to one or more other rooms to give a higher standard of house heating for the same expenditure of fuel. A convector fire operated to give a rise of 35°F. in the living room will give a rise of 15 to 20°F. in two other rooms. The latest models are designed for continuous burning and this is particularly useful during the coldest weather when it is most desirable to maintain a continuous flow of warmth to various parts of the house.

The Openable Stove

Another appliance which is finding much favour is the continuous burning open fire stove. The overall efficiency of the model with boiler is 60-75% for coke and 45-50% for coal. Like the convector fire it may be used to provide background heating in two or three rooms.

Reduction of Smoke Emission

It will be noted that the use of the open smokeless fuel grate will reduce the smoke emission to half that produced by pre-war coal fires when burning bituminous coal. Any increase of production of smokeless fuels will be readily taken up by users of these appliances to give a further reduction. Using a convector fire or open fire stove would give the same reduction when the warm air is used for background heating in other parts of the house but when used for supplementing the heat radiated to the living room a still further reduction is given, since the smoke emission per useful therm delivered to the room is less than one-third that of the better types of pre-war coal fire. There is, therefore, an even stronger case for the replacement of the open coal fire by the convector fire or openable stove in existing houses than in new housing, since in the latter the warm air is generally used to give a higher standard of house heating.

From these remarks it will be obvious that any modification to the appliance or the installation which will increase the useful thermal output per pound of fuel burned, will reduce the actual quantity of smoke emitted.

For example, the insulation of the hot water storage tank and the flow and return connections reduced the fuel required for a given hot water service to half that required for uninsulated systems, thus reducing the smoke emission by half when coal is used. Again, an improvement of the insulation of the exterior walls, roof and ground floor of a house to the standard recommended in Post-War Building Studies No. 19, will result in a fuel saving of 20-25% over pre-war constructions, so that for the same heating standard the smoke emission would be reduced by this amount. Still another method of conserving heat and indirectly reducing the smoke emission is to be found in eliminating the over-ventilation of the living room caused by an open fire. Only 1½ air changes per hour are required for good ventilation, but the open fire normally gives 4 or 5 changes. By ducting air from outside to a point as close to the fire as possible this air passes up the chimney without passing through the room and so reduces the quantity drawn from the room.

Future Developments

Mention should be made of the B.C.U.R.A. Hales fire which illustrates a method whereby the smoke emission can be reduced to ½ to 1% by weight of the coal burned. The overall efficiency of this fire is similar to that of the smokeless fuel fires already considered.

It has been noted that the maximum overall efficiency obtained when burning coal in a convector fire or openable stove fitted with boiler is 40-45%, as against 55 to 75% for smokeless fuels. The reason for the comparatively low efficiencies when using coal is found in the high flue losses obtained, these including an unburned gas loss amounting to 10-15% of the total heat available in the fuel. Therefore, until a design can be found which will appreciably reduce this loss, no further increase of efficiency or reduction of smoke emission can be expected. It is for the research worker to determine if improved combustion can be obtained and the open fire retained or whether a completely closed unit is necessary.

Gas Coke

By A. F. POLLOCK,
Solid Smokeless Fuels' Federation

B622

IN the Simon Report[1] it is stated that the programme of efficient and smokeless heating "will be practically complete when an additional twenty million tons of smokeless solid fuel are consumed annually with a working efficiency of not less than 40 per cent. for domestic heating."

In considering the contribution which gas coke may make to this programme, there is a number of questions to be answered, most of which are asked in the Opening Paper and which may be briefly re-stated as follows :—

(1) Will gas coke be generally acceptable as a domestic fuel ?

(2) How much of the twenty million tons required can be provided by gas coke, of what quality, and at what price ?

(3) Can the desired efficiency of 40 per cent. be attained with coke-burning appliances and, if so, what kinds of appliances ?

It is the purpose of this paper to try to give answers to these questions.

(1) *Will gas coke be generally acceptable as a domestic fuel?*

The acceptability of gas coke as a domestic fuel depends primarily upon four things :—

(a) The use of appliances suitably constructed for burning coke.

(b) The size grading of the fuel used.

(c) Proper facilities for storing and handling in the home.

(d) Consistency of quality and lowest possible ash content.

(a) The need for properly constructed appliances is well illustrated in the traditional domestic fireplace and grate, which were originally evolved and used for burning bitumenous coals of high volatile content, but which are quite unsuitable for burning gas coke of low volatile content and greater bulk relative to weight.

In view of the obvious advantages of using a smokeless fuel such as gas coke, work was carried out in the inter-war years in the research laboratories of some of the largest gas companies and as a result, a coke-burning open-fire was produced, having a higher efficiency than any coal fire and with other desirable features. Many thousands of these (100,000 in the London area alone) were being installed before 1939, and since that time they have been progressively improved both in appearance and performance. The lastest convector types of open coke fires with back boilers provide between two and two and a half times the amount of effective heat of the old open-fire for the same amount of fuel used and are being widely installed in the houses and flats of the London County Council and elsewhere.

Similar progress has been made with the small domestic hot-water boiler which has lately been the subject of a British Standard Specification[2] and which will now operate successfully and give overnight burning with all solid smokeless fuels of the correct size grading.

The majority of modern insulated cookers are designed for burning coke and other smokeless fuels ; they may provide hot-water supply as well as cooking, are continuous burning and very economical in fuel consumption.

Tests carried out by independent authorities show that the latest coke-burning domestic heating appliances give some 20 per cent. greater heat output than the most modern coal-burning appliances for the same consumption of fuel—a feature of the utmost importance in these days of fuel shortage.

(b) *Size grading of coke*

The efficiency in use of gas coke and its effectiveness as a domestic fuel are quite considerably dependent upon the size used. For instance, a small domestic boiler will not give satisfactory overnight burning if coke of too large a size is used. Similarly, the appearance and efficiency of an open-coke fire will be adversely affected if the size of fuel is outside the range 1 in. to 2½ in.

Considerable attention has been given to the proper sizing of coke by various bodies culminating in the "Report on Coke Quality" by the Institute of Gas Engineers.[3] That report lays down a recommended scale of sizes which should be adopted by all gas coke producers, and which meets the needs of all types of

[1] Cmd. 6762 Report by the Fuel and Power Advisory Council on Domestic Fuel Policy, Chap. XIV (5).

[2] B.S.S. No. 758-1945.

[3] Inst. of Gas Engineers Publication No. 252.

coke-burning appliances. The domestic consumer is concerned almost entirely with two sizes, the " nut " size and the " open-fire " size, within the ranges of ½ in. to 1¼ in. and 1 in. to 2½ in. respectively. It is desirable that the correct sizes of fuel to use in domestic appliances should be generally known and the various District Coke Associations are taking steps to disseminate this information.

(c) *Fuel Storage*

Experimental work in the construction of coke fuel stores has shown that, provided these are so designed as to permit of the fuel being shovelled from the floor level, coke can be stored in a space which does not make excessive demands upon the floor area of the house and in such a way that it is easier and cleaner to handle than coal.

(d) *Quality and Ash Content*

It is clear that the ash content and quality of gas-coke are largely determined by that of the original coal. It is consequently desirable that a national fuel policy should aim at directing to carbonizing plants those coals which are most suitable both from the point of view of gasmaking and of yielding good quality cokes of low ash content. Much can be done to improve the coal in these respects, by washing at the collieries, and it is to be hoped that it will be the policy of the Coal Board to instal coal-washing plants much more widely than has been the case in the past. Where cleaned coals are not available something can be, and is done by the installation of coke-cleaning plants at gasworks, but the greater advantage seems to lie with the cleaning of coal at the collieries, both technically in the carbonizing plants and in the avoidance of the transport of incombustible material in the coal.

Whatever the solid fuel used, however, ash will still remain. Clearly, therefore, appliances should be designed to make ash removal and cleaning as simple as possible for the housewife. Much has already been done in this direction in the designing of coke appliances by the fitting of deflectors which direct the whole of the ash into an ash-pan of adequate size, so that the process of ash removal consists in lifting out the ash-pan once a day or at less frequent intervals, in some cases up to a week.

Gas coke was already being fairly widely accepted as a domestic fuel before 1939, and having regard to the progressive improvement in appearance, convenience, and performance of coke-burning appliances, and to the advantages inherent in the use of smokeless fuels, there is every reason to expect that it will come to be accepted as the normal domestic solid fuel.

(2) (a) How much of the twenty million tons required can be provided by gas coke, and
(b) What will be the quality of the coke and
(c) Its price?

(a) *Quantity of Gas Coke available*

According to the statistics of the Gas Industry contained in the Ministry of Fuel and Power's Statistical Digest for the years 1938-45, some 2½ million tons of coke were used for domestic purposes in 1938. The additional 20 million tons envisaged by the Simon Report would bring the total requirements to 22½ million tons at least.

The amount of coke produced by the Gas Industry depends upon the amount of coal carbonized which, in turn, is determined primarily by the demand for gas, but also quite considerably by the technical processes employed at the gasworks.

In 1945, the industry was carbonizing some 21 million tons of coal per annum. This is less than it would be normally because, in order to reduce coal consumption to a minimum, calorific values of gas have been lowered, benzol production discontinued, and carburetted water gas (from oil and coke) made to the maximum capacity of available plant. If, through an improvement in the coal supply position, the Gas Industry could revert to its normal technical processes, the amount of coal required for carbonization would rise to some 25 million tons for the same quantity of gas sold.

Any expansion in the demand for gas would, assuming that the necessary extensions of carbonizing plant could be made, give rise to a corresponding increase in coal carbonized. The Heyworth Committee reported[4] " We have come to the conclusion that a reasonable forecast of the development of the Industry is that it will in ten years' time have increased its sales to at least 20 per cent. above the level of today (1945)." If this estimate is realized, gas production would require an additional 5 million tons of coal per annum, or a total of 30 million tons. This would result in a coke production of 15 million tons of

[4] Report of the Committee of Enquiry into the Gas Industry, Dec. 1945 (Cmd. 6699) Section 209.

which about two-thirds or 10 million tons could, with the gradual modernization of coke-screening and cutting plant, be made available in the sizes ½ in. up to 2½ in. suitable for domestic use. Whether it would in fact be avilable for domestic use, would depend upon the extent to which industrial and commercial heating plants could be converted from the use of coke the to smokeless combustion of bituminous coals or low-grade fuels ; such conversion would probably only take place under the conscious guidance and direction of the Ministry of Fuel and Power.

The Gas Industry then should be in a position to provide some 10 million tons of domestic coke by 1955. How much coke and smokeless coal can be contributed by the hard coke and coal industries will depend upon the policy to be pursued by these industries, which are dealt with in other papers before this conference. Estimates from various sources suggest that the amount may not be less than 7 million tons, making a grand total by 1955, of at least 17 million tons. Provided the necessary steps are taken to free this production for the domestic market, it will probably be sufficient to keep pace with the installation of coke-burning appliances in both new and old houses.

(b) *Coke quality—Free burning cokes*

What, now, of coke quality and the prospects of production by the Gas Industry of cokes which will be sufficiently free burning for use in the large number of existing appliances which probably cannot be replaced by coke-burning appliances in the next ten years ?

The production of free-burning cokes has been the subject of a study by the Gas Industry for a good many years past, though it cannot be said that any clearly defined policy has yet emerged. A good deal of experimental work has already been undertaken at various places, and here in Edinburgh, just before the war, the Corporation Gas Undertaking was beginning to produce a good-quality free-burning coke as a result of the work of Jamieson and King who, in their report on the subject to the Institution of Gas Engineers[5] came to the conclusion that " smokeless fuels which do not require special grates can be manufactured by the Gas Industry without interfering in any way with the normal procedure of gas manufacture and in such a manner that the residuals can be absorbed in existing markets." In Edinburgh, the cost of gas per therm would not be increased if the lump smokeless fuel realized a price ex works of 36s. per ton." This price compared with the then current price of the standard coke of 28s. 6d. per ton, and in present conditions the margins between the two cokes might be wider though, owing to the lack of suitable coals at the present time, no costs based upon actual practice are available. It should be borne in mind, however, that the difference of 7s. 6d. per ton was accounted for to the extent of 4s. 6d. by the higher price of the specially selected coals required to make this high quality low ash domestic fuel, so that only a relatively small proportion of the increased price was attributable to changes in the economics of the gas works process itself. Jamieson and King were of the opinion that there were adequate supplies of suitable types of coal throughout the country to permit of gas undertakings being able to produce a substantial proportion of their total coke output in the form of free-burning cokes. Nevertheless, it is doubtful if the distribution of suitable coals is such as to make these free-burning cokes available uniformly throughout the country without incurring considerable transport charges, and it is suggested that future policy should be directed by Housing Authorities to providing domestic appliances which will be capable of burning all types of coke and, if free-burning cokes are available at a price acceptable to the consumer, then so much the better, because there can be no doubt that even in the appliance designed for the combustion of unreactive fuels, the responsiveness and controllability of free-burning cokes are much better and the ash content is generally lower with the attendant advantages arising therefrom.

(c) *Price*

This brings us to a consideration of the subject of price in general. Obviously the whole economics of gas production are affected by the price obtainable for coke. It has already been shown that the production of coke per therm of gas made can be varied by changes in the carbonizing and ancillary processes, and the policy of the Gas Industry in the past has tended towards the production of less coke when the price of coke was so low as to make this course economically desirable. The subject of the relative economic advantages of making

[5] " Production of free-burning cokes in continuous vertical retorts." Inst. of Gas Engineers No. 199-82.

gas and coke has been admirably dealt with in the paper presented to the Institution of Gas Engineers by Mr. J. E. Davis, of the South Metropolitan Gas Company.[6] He has shown diagramatically the points in the relative prices of coal and coke at which it pays to change over to a greater production of one or the other. For instanc e, when the price of coal is £1 per ton, the net revenue from coke must be over 23s. 4d. per ton, if it is to be profitable to produce more coke. If the net revenue from coke rises appreciably above this figure, then it will pay to make coke; if it falls below, the tendency will be to reduce coke production in favour of gas production. Similarly, at the price of £2 per ton, the critical price for coke is 45s. 8d., and it is shown that as the price of coal rises the critical differential between coal and coke prices rises though (and this is important) not in proportion. Accepting these calculations, it would appear that the net coke revenue must exceed the cost of coal by a percentage varying from 16⅔ per cent. (with coal at £1 per ton) downwards as the cost of coal increases. It should be pointed out, however, that the differential varies according to the total number of therms recovered as gas and coke, rising as the total recovery falls to as much as 50 per cent. where the total recovery falls to 180 therms per ton. It is probable, however, that in an efficient gas works the differential need not exceed 20 per cent. The question is, therefore, whether the price of gas coke can be maintained at a level some 20 per cent. above the price which gas works pay for their coal. In this connection, the table of efficiencies in the Simon Report suggests that coke has a greater efficiency in use than coal in suitable comparable appliances, and that this advantage in efficiency is of the order of 20 to 25 per cent., so that in paying 20 per cent. more for coke than coal the consumer is receiving equal heating value for money with, in addition, the attendant advantages of a smokeless fuel. It is suggested, therefore, that the price of coke could be such as to encourage the Gas Industry to make the maximum possible coke without putting the consumer at a disadvantage in relation to the fuels formerly purchased. Such a price arrangement would also have the advantage of enabling the Gas Industry to maintain gas prices at a reasonable level and to promote the extended use of gas, which is the principal factor in determining the amount of coke produced.

[6] Inst. of Gas Engineers Publication No. 259.

(3) *Can the desired efficiency of* 40 *per cent. be attained with coke-burning appliances and, if so, with what kind of appliances?*

Referring again to Table 6 of the Simon Report, we see that the efficiency of an open-coke grate is 25 per cent. and of a closed stove 55 per cent. The table is already somewhat out of date. The following efficiencies have been arrived at under conditions of test which conform closely to actual working conditions and which are now being standardized by arrangement between the Ministry of Fuel and Power Research Station and the Gas Industry Research Station.

	Per cent.
Conventional open-coal fire	22–26
Modern Smokeless Fuel Appliances	
1. Convector open-coke fire	50
2. Open-fire with back boiler for heating domestic hot water and radiators	50–57
3. Convector open-fire with back boiler for heating domestic hot-water and radiators. With inset stoves having closeable doors the corresponding efficiences are 4 per cent. to 5 per cent. higher with the doors closed.	55–65

It is evident from these figures that having regard to the latest developments in coke appliance construction, the efficiency of 40 per cent. desired by the Simon Committee can be easily achieved and even substantially exceeded, and that without sacrifice of the open-fire, which is reputedly so dear to the hearts of the the British people.

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Low Temperature Carbonization

By Col. W. A. BRISTOW, M.I.E.E., F.R.Ae.S.,
Low Temperature Coal Distillers' Association

THE Survey on the Prevention of Domestic Smoke which we are discussing today is, I think you will agree, a valuable contribution to the literature dealing with this important subject.

This paper goes far beyond the field of the virtues of smoke abatement as such, and its assumptions and suggestions are open to some criticism. The Society is performing a valuable public service in drawing attention to the necessity for improvement and the highly complex nature of the factors which have to be taken into consideration. At present there is no national fuel policy. The production of coal is so far below our requirements and the problems inherent in its wise distribution are so serious that it is extremely difficult to decide upon any long-term plan, and indeed on any short-term plan. However, there is nothing to be lost in the ventilation of opinions on all these very interesting points. It is all to the good that the many virtues of solid smokeless fuels and their great advantages as a medium for domestic heating should once more be brought forcibly to the public mind.

In thinking out a plan for national smokeless heating there is a danger that in our desire to abolish smoke we may substitute another evil. For example, the Survey suggests that the open fire may be largely displaced by a vast extension of central heating both in separate household installations and by schemes of district heating. The suggestion is also made that it may be possible to transfer the burden from solid fuels to electricity but quite overlooking the questions of cost, the lack of the necessary plant and the very low overall thermal efficiency of electricity when applied to domestic heating. We are, of course, all fully aware of the enormous benefits that have been conferred upon the community by the expansion of the electrical industry. There are some purposes, however, for which electricity is unsuitable, and domestic heating on a large scale is an example. For every 100 tons of coal burnt under the boilers in the generating station the heat from only 18 tons reaches the consumer and the country just cannot afford it. Further, the present generating capacity is below 2,000,000 kilowatts. To cope with our present requirements it should be at least 20% greater and if our industries are to be expanded it must be greater still. It is vitally important that we cut down our domestic consumption of electricity to the irreducible minimum otherwise industry will be seriously hampered and unemployment will be created.

With regard to central heating, I think that there is general agreement in this country that to abolish the use of the open fire in favour of central heating would be a very undesirable step. The author of the Survey suggests that when central heating becomes universal open fires can be abolished or used only for emergency purposes. This theory is, I think, highly dangerous. First of all, the cost would be tremendous, secondly it could not be applied easily to the millions of houses already in existence, thirdly all the volatiles in the coal (if coal were used) would be burnt for fuel with very heavy loss to the nation. Whilst it might be true that some such boilers normally use smokeless fuel, they obviously could not use it if the practice became general because there would not be enough smokeless fuel available. I disagree that central heating for the small house is gaining in popularity. On medical grounds alone it would be a very retrograde step to banish the open fire in favour of central heating. There may be a case for installations in new blocks of flats with a view to providing auxiliary space heating as part of the hot water system. Even in such cases there should be the usual flues and other facilities so that the tenants can burn solid fuels, or fit gas radiators for intermittent heating if they so desire. It has also yet to be shown that central heating would result in any saving in fuel as compared with modern appliances burning solid smokeless fuels.

With regard to district heating, it has not yet been demonstrated that district heating can be accomplished satisfactorily either from a technical or economical point of view. It certainly would be almost impossible to instal it in any existing towns. The idea of tearing up the roads once more to lay hot water or steam mains to every house sounds difficult in the extreme. It is proposed to instal pilot installations in certain new housing estates and we shall have to await results before we can come to any decision. There is one danger; local authorities are playing with the idea that they may embark upon the scheme here and there. It may be most expensive and inefficient but the loss might be hidden in the general rates and the community will be taxed, in effect, for a scheme of which they are not particularly fond and which they may not want to use.

I submit that the reply to the question asked in the Survey is: that the three central services—gas, electricity and central heating cannot displace the solid fuel fire in the living rooms because, smoke or no smoke, it is the healthiest,

best, and cheapest method for continuous domestic heating. The only way to eliminate the coal fire in the living room is to replace the coal with smokeless fuel of a reactive and free-burning type.

According to the Simon Report 86% of domestic heating is derived from solid fuel, 10% from the gas industry (that is, gas and coke), and 4% from electricity. Even if these figures are only approximately correct it is obvious that not for many years to come could the present gas and electricity industries cope with anything like the total demand.

The Report admits that on technical grounds there is no early likelihood of it being possible in the next few decades to do away with solid fuel, but why should we wish to do away with this cheap and magnificent fuel which has for so many years constituted the backbone of our supply of domestic heat. There is a very good argument in its favour which is seldom mentioned, namely, that during the summer when the demand for heat is reduced, it is possible to build up in the home and in the merchants' yards stocks of solid fuel, the availability of which in the winter does so much to help the country deal with the winter peak. Further, the householder with two tons of solid fuel in the cellar may be very much better off than the man who has to rely upon supplies of district heat, gas or electricity derived from central stations which, as has been shown, sometimes find it necessary by reason of their own difficulties to reduce or cut off supplies altogether.

Before leaving this part of the subject it is perhaps important to remember that solid fuel costs less than 4d. per therm, gas about 1/2d. per therm or more, and electricity at 1d. per unit is 2/5d. per therm. With an openable stove combining the open fire and the closed stove it is possible to run continuously and maintain good heat in a large room for an expenditure of about ½d. per hour. The stoves will run day and night over long periods without re-lighting and therefore the amount of work required for their maintenance is considerably reduced. No other form of domestic heating can compare in efficiency with these stoves, when the right fuel is used, and they can also be provided with back boilers. It is, I submit, wrong to adopt a policy of trying to make excuses for the open fire. On the contrary, it should be boosted in its modern form as the best method of obtaining healthy domestic heat at the lowest possible price with a minimum of work.

The Smoke Abatement Society has for some time been advocating the establishment of smokeless zones in or around our big cities, but excellent though this scheme may be in theory it is very difficult to put it into practice at the present time, in fact, to do so might inflict a good deal of harm upon the whole movement. For example, supposing a district of Manchester is outlined in which no smoke is to be emitted, how can we expect to carry this fairly and properly into effect unless and until there is sufficient smokeless fuel available? The only effect would be to force upon a large number of the unfortunate inhabitants the necessity for using gas and electricity for permanent space heating. This, although it might help to clear the air, would impose a far greater hardship upon the population than would be occasioned by the small proportion of total smoke which that district would make. Also, the term "smokeless zone" is somewhat misleading. It is obviously impossible to make a smokeless zone unless we can put high walls round it, as smoke from other areas carried by the prevailing winds will to a large extent produce almost an equal distribution of smoke, even though one portion of that city may not be emitting any. It would be impossible now to prohibit the use of raw coal with justice and by public agreement because there is nothing practicable to take its place on a sufficiently large scale.

This gap in supplies of smokeless fuel must be bridged as rapidly as possible, and this is one of the main recommendations of the Simon Report.

The National Coal Board has taken the matter up, and a Panel has been appointed to consider and to decide upon the best means by which production may be continuously increased by one million tons per year.

There is another reason why we must adhere to the policy of carbonizing all the coal we can and using the residual smokeless fuel.

Science has now demonstrated quite clearly that to burn bituminous coals in the raw state is to destroy vast quantities of oils and chemicals that are the vital raw materials of other industries. It is a most regrettable fact that today we are burning as fuel on a tremendous scale materials which are being exported at £50 per ton. For these materials there is such a strong and ever-growing demand that we could sell ten times as much as at present.

In the making of smokeless fuels by carbonization there are produced—benzole: petrol: Diesel Oil: phenols and cresols for the plastics and other industries: tar acids for disinfectants and germicidal products: creosote for timber preservation on a large scale: and a number of other essential products. A large percentage of these are exported to dollar countries and the manufacture of benzole, petrol, and Diesel Oil from our own coal correspondingly reduces the necessity of importing these essential fuels.

The price of coal today—and it may go higher still—surely must compel us to resolve it into its component parts, that is the gas, the cokes, and the liquid products.

This is not a laboratory dream. Last year the gas industry, the coke ovens, and the smokeless fuel plants produced over two million tons of crude tar from which all these valuable products are obtained.

I submit therefore that now that the Smoke Abatement Society has made the country smoke conscious, it should henceforth concentrate its attention upon the means by which its aims can best be realized. In the national interest, and having regard to the main governing factors, we must have :—

(1) The cheapest, most convenient, and smokeless methods of heating our homes.

(2) The type of heating that is most beneficial to the health of the nation.

(3) The type of heating that permits of the most scientific utilization of the coal and of the valuable substances it contains.

There is one and only one answer to these three demands, namely, the extension of the use of smokeless solid fuel as manufactured by the carbonization of coal, combined with the most up-to-date, scientific methods of recovering and refining of the many valuable liquid products obtained in the process.

We are all aware of the serious position in which we find ourselves today, and here is a target at which every household may aim, for their own good, and for the benefit of the nation generally.

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Anthracite and Dry Steam Coals—The Natural Smokeless Fuels

By DONALD HICKS,

Director of Scientific Control, National Coal Board

Introduction—The Quality of the Coal

1. The South Wales coalfield is the main source of British anthracite and dry steam coal; a small tonnage of anthracite is mined in Scotland.

2. Most of the seams as they occur in the ground are inherently of high quality, being comparatively low in ash and sulphur. The run-of-mine coal is not of itself difficult to prepare in a satisfactory state for the market and with modern coal preparation plant fuels of high quality both in respect of size and ash content can be made. A programme of tuning-up existing preparation plant is in hand and new coal preparation schemes are being planned.

Past, Present and Future Outputs of Anthracite

3. The Ministry of Fuel and Power Regional Survey Report on the South Wales Coalfield published by H.M. Stationery Office in 1946, gives a fairly comprehensive account of the South Wales coal industry and the statistics quoted hereafter are taken from it.

4. The saleable output of anthracite in pre-war days was approximately 5½ million tons. It must be remembered, however, that about 60 per cent. of the saleable output of anthracite was exported leaving only between 2 and 2½ million tons for inland sales. The total saleable output of anthracite has decreased considerably since 1939, and is now of the order of 3 million tons with a negligible quantity available for export.

5. The difficulties of increasing the output from existing collieries with the present labour force will not be easily overcome. Some of these difficulties, and in particular the low output per man shift, are referred to in the Regional Survey Report.

6. Long term developments involving new sinkings in the virgin areas, south of the existing collieries which were planned by the colliery companies before nationalization and confirmed by the Regional Valuation Board when assessing the workable reserves were designed to achieve an average annual output during the next 25 years of about 7½ million tons. The competing claims of plans in other parts of the coalfield and elsewhere, where favourable mining conditions and other factors justify major expenditure, are likely to fix the 7½ million tons of saleable output per annum as a target for many years to come.

7. When the output increases the desirability of exporting anthracite will have to be carefully balanced and adjusted with the increasing demands of the inland market for this class of fuel.

Marketed Grades and Classes of Consumers of Anthracite

8. To give further precision to the problems of availability it is necessary to consider the output of saleable coal in terms of the sizes of the marketed grades and claims of various classes of consumers.

9. The saleable coal is marketed in various sizes and the total is made up as follows (Table XV Regional Survey Report).

Thro' coal... ...	5.0 per cent
Large and Cobbles	27.8 ,, ,,
Nuts	18.9 ,, ,,
Beans, Peas Grains	21.1 ,, ,,
Duff	23.4 ,, ,,
Other sizes ...	3.9 ,, ,,
Total	100.1

10. For most practical purposes one can assume that 25 per cent. of the output is duff, mainly of size 3-16 in. This not suitable for domestic coal and in pre-war days it was difficult to dispose of it for any purpose, and much of it was dumped, and the remainder sold at an uneconomic price. Recent and planned power stations with boilers designed to burn anthracite duff will probably consume all the current output of duff and any additional tonnage likely to be available in the next few years.

11. About 50 per cent. of the output is sized coal, ranging from cobbles to grains and about 20 per cent. is large coal. In fact, only about half of the inland sales is available for the domestic consumer. The very nature of anthracite, particularly its slow-burning characteristics and smokelessness, make it indispensable in certain industries especially in the brewery and horticultural trades which consume about 15 per cent. of the saleable output. Considerable tonnages are used for the manufacture of clean producer gas in the iron, steel and engineering industries.

Past, Present and Future Outputs of Dry Steams

12. Published statistics on the availability and disposals of dry steams are not available but the picture is not markedly different from that of anthracite. Past and present outputs of this class of coal are on an average, slightly less than those quoted above for anthracite namely 5 and 3 million tons respectively. Present colliery capacity is sufficient to handle a considerably increased output and an output even greater than that in 1938, when it was approximately 5 million tons. Availability of man-power is the chief determining factor in obtaining increased output. Concentration and reorganization schemes visualized by the planning engineers before nationalization were designed for a total annual output of this class of coal of about 6 million tons per annum during the next 50 years. This is approximately double the present output and it would be optimistic to expect this tonnage to be realized quickly.

The Disposal of Dry Steams

13. The gross output is washed and screened into a series of graded coals similar to the anthracite and as in the anthracite field the natural yield of sized grades is augmented by breaking the large coal. The disposal of duff was almost as difficult a problem as with anthracite, but here again developments in the electricity industry and extensions to existing power stations and the building of new power stations near to the sources of these coals absorbed large tonnage of the dry steam duff.

The Briquetting and Carbonizing of Dry Steams

14. The successful commercial development of the briquetting and carbonizing of dry steam duffs to produce the phurnacite product has added a very good smokeless fuel for domestic purposes. An extension of the present plant might make available a quarter of million tons of prepared smokeless fuel per annum. Increased availability of this class of fuel will depend on bigger outputs from the collieries and on the competing demands of the growing electricity generating industry in the South-Western region. There is a possibility, however, that the phurnacite process can be adopted in some of the other coalfields and experiments to this end will undoubtedly be carried out.

Hard Coke

15. The demands of the iron, steel and engineering industries absorb nearly all of the present make of hard coke. Extension of the coke oven industry, especially as part of gas grid schemes may well result in an additional tonnage of hard coke being available for the domestic consumer. Control of the carbonization process should ensure a fuel suitable for use in the appropriately designed appliances.

Summary

16. From the broader angle of smoke abatement a satisfactory result is obtained however these classes of coal are used. They are naturally smokeless.

17. The saleable output of all grades of anthracite and dry steams together is at present approximately 6 million tons per annum of which probably not more than $2\frac{1}{2}$-3 million is used directly by the domestic consumer in closed and openable stoves and in hot water and central heating boilers. The remainder of the inland sales is consumed by the electricity industry and by other industries with special demands for these classes of coal

18. The total pre-war output from existing anthracite and dry steam coal collieries was about 10 million tons. The main deterrent against regaining this output is the shortage of man-power, and to some extent the comparatively low output per man shift.

19. There are ample reserves to allow of an expansion of the output of both anthracite and dry steams and the South Wales colliery companies before nationalization had planned developments to give an annual output of the two classes of coal together of about 13 million tons which is double the present. It has been shown that not all of any additional tonnage can be made available to the domestic consumer because certain sizes, duff in particular, which amounts to a quarter of the output, is unsuitable.

20. When the output increases the desirability of exporting anthracite on the scale previously carried out, will have to be carefully balanced and adjusted with the increasing demands of the inland market for this class of coal.

21. There is a possibility of developing the phurnacite process in other coalfields and extensions to the coke oven industry will make available, in time, a certain tonnage of hard coke suitable for the domestic market.

Discussion

John Roberts (Severn Valley Gas Corporation) replying to Mr. Marsh's question " What is the policy of the carbonizing industries towards the production of coke for open grates ? " said that the policy was largely bound up with that of the National Coal Board, for two reasons (1) the producer was responsible for the quality of the coal which forms the raw material and (2) the consumer was denied free choice of the coals which he considered most suitable for the manufacture of the coke he would desire to produce. The ash content of the coal had increased very appreciably during the past 8 years, and an increase of X per cent. of ash in the coal meant one and a half times that increase

in the percentage of ash in the coke.

In Question 19, Mr. Marsh appeared to think that a smokeless heating agent should be no more expensive than the raw coal it displaced. Mr. Roberts did not agree that a superior fuel should not be more expensive than an inferior fuel. In that connection Question 35 should also be considered where it was stated that if the electrical industry took up the who'e of the domestic heating load the prob'em would be simplified. The heating of rooms by electricity was expensive, even though the domestic consumer was subsidised at the expense of the industrial consumer. Mr. G. M. Gill had recently published some figures showing that industrial consumers were charged 1.092d. per unit, while the domestic consumers were charged 0.767d. per unit.

Commenting on Mr. V. W. Dale's paper, Mr. Roberts said that it was interesting to contrast the attitude of the electrical industry with that of the gas industry. Mr. Cross would not advocate gas for central heating or for heating a room continuously all day, but Mr. Dale considered there was nothing basically wrong in electrical heating, which was much more expensive than heating by gas. Most modern gas executives were of the opinion that one heating agent was more suitable than another for a particular purpose, and many preferred electricity to gas for lighting: on the other hand the electrical industry wanted to take over the power, heating and lighting, lock, stock and barrel. Mr. Dale said that *if* all the homes of the country were constructed with a view to the conservation of heating, they could be heated electrically without increase in the amount of fuel, but he appeared to overlook the fact that any fuel used for heating would enjoy the same advantage by insulation, so that the relative values would be undisturbed.

It had been pointed out by Mr. Sayers, the Deputy Electrical Engineer of Birmingham, in a letter to the Birmingham Post during the height of the fuel crisis last winter that: "Every kilowatt of electricity used in the home meant the consumption of about 1½ lbs. of coal at the power station." If it was assumed that 1 therm of gas provided as much usable heat in the home as 20 units of electricity—a commonly accepted comparison—then 30 lbs. of coal, on Mr. Sayers' basis was used at the power station to give the equivalent of 1 therm of gas, which, on the basis of 80 therms per ton of coal used in the gasworks, was produced by 28 lbs. of coal. 28 lbs. of coal carbonized in a continuous vertical retort plant would yield 12.6 lbs. coke and 2 lbs. of tar for sale, or a total of 14.6 lbs., which left net coal used 13.4 lbs., plus 0.67 or 14.07 lbs., after allowing 5 per cent. for gas leakage on the district, as compared with 30 lbs. at the generating station. Thus for an equivalent amount of usable heat in the home when supplied by gas only 46.9 per cent. as much coal was used as compared with the quantity used in the power station for the same amount of heat used by the consumer in the form of electricity.

With regard to gas coke, Mr. Roberts said that there was no doubt that if and when the gas industry was allowed their choice of fuel they could manufacture very desirable open grate smokeless fuels, which could be used not only in modern coke grates but also n common stool grates. It was demonstrated at the Rugeley Gas Works, about two years ago, that by carbonizing nut sizes of non-coking coals a very reactive open-grate coke could be produced. Mr. Roberts concluded by saying that over twenty years ago it was shown that by blending coking and non-coking coals in intermittent vertical retorts reactive open grate coke could be produced which gave considerable satisfaction.

Councillor Mrs. M. Dale (Wolverhampton) said she felt in an awful muddle after hearing the speakers. Electricity was cut off, gas was cut down, fuel was unobtainable—what was the housewife to do—have all three installed or to try one or the other? In her estimation, district heating was the best. They wanted warmth and hot water, and this seemed to be the cheapest method. Mrs. Dale asked how could they begin to educate the women if they did not know which to recommend?

Dr. J. S. G. Burnett (Chadderton) referring to certain practical problems facing the housewife in her new home fitted with a smokeless fuel grate and an openable stove, drew attention to the heavy increase in price that had taken place in household coke in the past ten years so that coke delivered to the domestic consumer was now as expensive or more expensive than an equivalent weight of coal. He questioned the submission that there was a fairly considerable body of opinion in the general population favourably disposed to coke as a fuel in the ordinary household, and suggested that alternatively con-

siderable opposition to coke as a household fuel was actually being created at the moment among householders, who, through no fault of their own, were forced to burn coke in old fashioned unsuitable grates. However sound the scientific arguments were, and he did not question their soundness, in favour of a price level to the gas industry of 20 per cent. in excess of the price of raw coal, it was psychologically unsound to inflict that price on working class domestic consumers whilst these consumers looked on coke as a less attractive household fuel than raw coal. There was good reason for the Society suggesting to the Ministry of Fuel and Power that coke to the domestic consumer, particularly those possessing modern fuel appliances, should be available at a price level less than that applicable to an equivalent weight of raw household coal.

W. L. Mather (Mather & Platt, Ltd.) said that they would all like to feel that something concrete came out of the conference and not only words. As a first step he suggested that a British Standard Specification for fuel burning appliances should be drawn up, and this should give minimum standards of heating efficiency and cleanliness. The standard should be drawn up in conjunction with interested parties, such as Government Research organizations, trade organizations and the Society. He said that once a B.S.S. was promulgated, no fuel burning equipment should be allowed to be marketed that did not conform to it. He asked the representatives of trade organizations, who had just spoken, if they would be prepared to assist in the suggestion.

(In a later note, Mr. Mather points out that the replies by the trade organization representatives concerned did not answer his questions.)

J. S. Hales (British Coal Utilization Research Association) said that one of the most practical methods of reducing atmospheric pollution was by using more efficient appliances which reduced the amount of coal they had to burn to produce the necessary warmth and hot water. At the present time probably over half the coal used for domestic heating was burned in some form of open fire. Although great advances had been made in the design of open fires, they must remain relatively inefficient. Efficiency figures had been quoted in some of the papers of over 60 per cent. for open fire type appliances; these figures were over-optimistic and something nearer 40 per cent. was about the figure for the improved fires when burning coal. A more concentrated effort in the use and development of closed fire appliances would enable efficiency to be considerably improved.

He said that a further means of effecting a considerable reduction in fuel consumption was by proper layout and insulation of the hot water system. Much had been said about this in the past, but much still remained to be done. Another factor of importance was the position of the appliances in the house, and the insulation of the structure of the house itself. There were still far too many houses being built with flues on outside walls and poor structural insulation, which usually means that far too much coal was burned to maintain the inside room temperatures.

Many of the points he had mentioned applied only to new houses; for the millions of existing houses which formed the bulk of dwellings, the two main improvements possible were the substitution of appliances of the semi-closed type, having much higher efficiency than the open fire and the proper insulation of the hot water system. Mr. Hales said these methods would at least reduce the amount of coal burned and hence the amount of atmospheric pollution.

Councillor G. Anderson (Lanark) said that one possible domestic source of heating had been overlooked, namely utilization of waste gases from industrial plant. Within heavy industry large quantities of waste gases were going up the chimney instead of being turned into a gas grid for further use. He mentioned one particular factory where 17 million cubic feet of gas was being given off as waste heat per week. The recovery of this heat would mean a saving of 94,350 tons of coal per week on a basis of 18,022 cubic feet of gas per ton of coal. He said the Government should be approached asking them for a share of the £168 million which was to be spent in the re-organization of the steel industry and use it to stimulate economy and efficiency and to eliminate waste.

G. C. Smith (Coal Utilization Joint Council) spoke of the conflict of opinion as to the respective merits of the various methods of providing heating and hot water services. He believed that for many years the demand for open fires and the domestic boiler would continue, while District Heating did not provide for cooking. Moreover, there seemed no reason why the modern household

appliance should compare unfavourably with a central plant from the standpoint of coal conservation and smoke abatement.

Figures given in the Egerton and Simon Reports showed there was little to choose between pre-war solid fuel, gas or electric appliances from the standpoint of " Utilization efficiency " or coal conservation. The available efficiency of the average gas or electric appliance was 16 to 18 per cent., which compared with the same figures for the pre-war type of domestic appliances. The *modern* solid fuel burning appliances, however, had an efficiency of 45 per cent. and it was extremely doubtful if an appliance utilization efficiency of more than 25 per cent. could be secured from gas or one of more than 33 per cent. from the " straight " electricity generating station. " Thermo-Electric " stations might certainly show generation efficiency in the region of 70 per cent., but their general adoption was unlikely for many years, nor could they provide for rural or scattered areas.

Mr. Smith pointed out that Mr. Cross, in his paper on Gas, had drawn attention to the immense task of inducing house-owners to scrap inefficient and obsolete equipment. This vital problem should receive much greater attention than it was getting. The equipment of new houses was, by comparison, a straightforward matter and here the Ministry of Health, the Ministry of Fuel and Power, and the Coal Utilization Joint Council, were making considerable headway in inducing Local Authorities to install efficient and smoke reducing appliances. There remained the problem of the 12 million or so existing houses, and the National Smoke Abatement Society would do a real service if it devoted its energies to it. The official view of the C.U.J.C. was that there was room in every home for all fuels.

W. B. Kennedy (Manchester) said that in his opinion the ordinary open fire was nothing but a draught - making apparatus, and in spite of various schemes to reduce this excessive draught it could never be really efficient either for heating or ventilation. He considered that the installation of open fires for " topping up " purposes the height of absurdity. In the Ministry of Fuel and Power and the Department of Scientific and Industrial Research report " Domestic Heating in America " paragraph 1 : 32 appeared the following statement : " A number of people suggested that in the really cold weather the lighting of an open fire caused a draught up the chimney which in turn caused cold outside air to be drawn into the house with a result that the air was cooled and the thermostat caused more fuel to be burned in the main heating furnace. The fire, in other words, acted as a cooling device. There was some evidence to support this view." The report went on to state that air ducts taken from outside the house to an opening near the fireplace would avoid much of the " cooling effect " due to excessive cold air.

The openable stove overcame these disadvantages. Even when used as an open fire the restricted flue outlet prevented excessive draught. In the " closed " position the fuel economy was amazing. Mr. Kennedy went on to describe the openable stove in use at his own home from the end of September till the end of May each year, burning day and night using bituminous fuel owing to the difficulties in obtaining coke. He had recently found how to " work it " with his coal dealer and he now hoped to obtain regular coke supplies. With ordinary coke there was difficulty in maintaining combustion at low rates of burning. Coke produced by the low temperature carbonization process seemed ideal. The average annual coal consumption was about one and a quarter tons per year. The weekly consumption varied from a minimum of 28 lbs. per week (seven shovelfuls) in October to about 140 lbs. per week in January. Domestic water heating was by a gas circulator, cooking by gas, and electricity for space heating between June and September. In the five-year period 1940-1944 the total gas electricity and solid fuel costs for these purposes averaged about 4s. 10d. per week. Time did not allow Mr. Kennedy to give a more detailed statement, but the Ministry of Labour estimated a working class expenditure in pre-war days of 6s. 5d. per week on fuel and light, so he had been well under working class fuel and light expenses. There were, he said, several faults with these stoves. The principal one was that the makers generally had no idea of domestic hygiene. One had only to inspect the inside of a wireless cabinet after a few weeks' use to realize the amount of dust caused by the wear and tear of carpets, etc., in daily use. This dust was trapped in the " convection space " became scorched and the finer particles emitted, possibly causing an unpleasant smell

and assisted the discolouration of walls and ceilings. Dr. Meetham in his paper, had pointed out that it took only about half an ounce of soot to blacken the average size ceiling. Mr. Kennedy said that he had noticed that some of these stoves were being fixed with no warm air outlet to the living room; instead, an inaccessible duct conveyed the uncontrolled warm air to a bedroom, where it was not usually required. If this warm air was admitted to the living room less fuel would be required and the warm air could diffuse throughout the house.

Leslie Hardern (British Gas Council) said that most of the papers that day had dealt with the provision of efficient equipment in new homes. It must be borne in mind, however, that even if the Government's highest expectations were realized, and four million new houses were built in the first ten years after the war, there were still eight million of the existing houses, with inefficient equipment, in existence at the end of the ten years. No reference had been made during that afternoon to the proposal in the Simon Report that equipment in existing houses should be replaced by means of Government subsidies. It had been proved that the total full consumption of the ordinary household could be reduced from 5 tons to 4 tons a year by substituting new efficient equipment in place of existing equipment. Most of this saving came from the installation of a modern open fire capable of burning smokeless fuel. Some of these modern fires cost as little as £3 with another £2 for installation. A Government subsidy of £5 per installation would come back to the nation in terms of coal conservation within 2 years, and after that would provide an annual dividend in both coal conservation and smoke abatement.

Donald V. H. Smith replying to the discussion said that the actual costs of heat of some methods had been ignored by many; others had suggested that District Heat would be very costly. He wished to state categorically that given reasonable co-operation by local authorities in a suitable layout of an estate, district heat ought to be the cheapest of all methods. He directed attention to the schedule of total costs of heating by various methods, attached to his paper.

The extra charge, to be borne by the tenant, would not include the capital charges on internal works which were already being covered for in normal rents. The actual cost of district heat to an average size council house, giving 30 per cent. to 50 per cent. more heat than by traditional methods, should normally work out at between 6s. and 7s. per week. Central heating was just a little more but no other method, providing an equivalent heat service, could get down to that low figure.

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Grit and Sulphur Emission Problems

Introductory Remarks by the Chairman

BAILIE JOHN G. BANKS, J.P.

Chairman of the Public Health Committee, Edinburgh City Council

IT is a special honour and pleasure for me to preside at this session of the National Smoke Abatement Society Conference.

As Chairman of the Edinburgh Public Health Committee, I may say that my Committee were glad when they heard that your Society proposed to hold this year's Conference in Edinburgh. The Public Health Committee are keenly interested in the subject of smoke abatement, and I feel certain that the publicity which is being given to it this week will be of great assistance to them in raising a keener interest amongst the general public, and especially those who contribute in any way to the problem.

My Committee are gratified that their Chief Sanitary Inspector, Mr. Ritchie, is President of the Scottish Section of your Society. I do not need to enlarge on the keen interest that he has taken in the campaign for securing a cleaner atmosphere. We in Edinburgh are more favourably placed regarding pollution of the air than the more industrial parts of the country. We have, however, our own peculiar problems. As you know, the City is largely residential, and we soon hear of any offence caused by excessive smoke emissions, and some of our own civic undertakings are not free from criticism.

It is well-known, of course, that at the present time the quality of fuel being supplied does not compare with that in normal times. We hope that this position will be rectified at an early date. The greatest cause of pollution by smoke in a city like Edinburgh is that which arises from domestic fireplaces. The appellation "Auld Reekie" so often applied to the City had its origin in the curling smoke arising from the habitations of former days and seen from the towns and villages on the other side of the River Forth. But now the modern clamour for a cleaner atmosphere demands that our present methods of heating dwelling-houses will be displaced as quickly as possible by the new and cleaner methods of heating.

Already much has been done in the City by the increasing use of gas and electricity, the use of which these days unfortunately is somewhat restricted. Those who desire to continue with open fireplaces need not do so to the detriment of their neighbours, but can use one or other of the modern solid-fuel burning appliances. It is hoped too, that in the development of our new housing schemes, much greater use will be made of central and district heating.

The discussion this morning, however, does not refer so much to these matters as to a particular aspect of the smoke abatement problem, namely, grit and sulphur emission. The emission of grit and sulphur from the larger industrial works and power stations is a matter of serious import in certain parts of the country, and any suggestions that can be made to have it rectified are worthy of serious consideration. I know there may be difficulties in the way of getting new plant introduced at the present time, but when re-organization of industry takes place, measures should be adopted that are capable of reducing this nuisance to a minimum. I am happy to say that at our own electric power station at Portobello, any sulphur emission is practically invisible and the prevailing winds carry it out to sea.

As regards grit emission there, it is proposed in the new extension at present under construction, to include new electrostatic precipitators for dealing with the grit.

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Survey of the Present Position

By V. SILVER and ARNOLD MARSH

ATMOSPHERIC pollution from industrial sources can be divided into smoke, grit or fly-ash, and sulphur oxide gases. Smoke, defined as unburned carbonaceous matter, may be prevented by ensuring efficient combustion, but pollution from the other two constituents may, and does, occur when furnace efficiency is high and no visible smoke is being emitted. It does not pay to prevent their emission in the way that it pays to prevent smoke, and their removal from the flue gases may add materially to the cost of steam. The present session of this conference is devoted to the problems of these pollutants, as distinct from smoke, because of their increasing seriousness and the remedies for each are either identical or related.

To what extent actual specific nuisances exist from grit and sulphur, as distinct from their general effects when they are emitted to some extent during most fuel-burning operations, is not known. Only from a detailed questionnaire to every local authority, and an exhaustive analysis of the replies, could a complete picture be obtained. This was not possible for our present purpose and all that could be done was to note and collate all cases of which the Society had knowledge, either through correspondence or through the Press cuttings we receive.

We have, therefore, compiled a record of over thirty recent cases—all occurring within the last 18 months—of grit or sulphur emissions, most of which have for this report recently been verified and amplified by the local authority concerned. Of these, fifteen relate to electricity generating stations, four to gas works, four to iron and steel works, two to collieries and the remainder to miscellaneous works and processes. The information available is in some cases non-technical and in a few there is doubt as to the precise nature of the emission complained of.

It will be appreciated that the number of cases quoted is simply the number we happen to have known about, including those that for some reason have had Press publicity. The number is no guide whatsoever to the general prevalance of grit and sulphur "nuisances" throughout the country.

Electricity Stations

It will be seen that the class of installation most concerned is easily the electricity generating stations. As is generally known only two of the largest stations are equipped with flue gas washing plant for the removal of sulphur gases, but the cases recorded are nearly all with respect to grit emission only. There is no doubt that difficulties have sharply increased during and since the war, because of the quality of coal supplied. In one instance, for example, it is stated that whereas before the war half the coal supplied to the station was washed, and the other half had an ash content of 8 per cent., the proportion of washed coal is now only 40 per cent. and the remainder, of which about 17 per cent. is dust, has an ash content of from 15 to 18 per cent.

It can be seen from the reports that the installation of efficient grit arrestors leads to considerable improvements—in one instance it is reported that since arrestors have been installed the nuisance has ceased; in another, however, although a nuisance of long standing has been dealt with by modernising the plant and adding the best available grit arresting apparatus, " the nuisance is still not entirely abated."

One report shows that an increase in ash content of coal not only directly increases the quantity of ash in the flue gases, but, by clogging the gas passages in the boiler, especially around the bottom bank of tubes, restricts the flow of gas, increases its velocity, and causes it to entrain an even higher proportion of

grit. Instead of a normal run of 600 to 1,000 hours before being shut down for cleaning, the boilers have only a run of 500 to 600 hours.

Direct references to sulphur acids emission are less frequent, doubtless owing to the fact that in most cases the effects of these gases are not so easily traceable to a specific source. Of the two stations equipped with the necessary plant, one is again washing the flue gases after wartime disuse, but the other is not likely to have its plant working again for another 12 to 18 months. It is, however, hoped, as an interim measure, to have a grit arresting plant installed and operating by the spring of next year—in this instance complaints about grit have been numerous.

The scale of pollution from sulphur oxides gases that may arise is illustrated by a report on four generating stations situated along a single valley. The total quantity of fuel burned by the group is nearly 1,200,000 tons a year, representing an emission of about 40,000 tons of sulphur dioxide, or over 100 tons a day. These stations have schemes for extensions that will substantially increase the emission unless preventive action is taken. The chief engineer concerned has stated that it is impracticable to install flue gas washing plant on other than new installations, and then only if there is sufficient room. In one case he estimates that the cost would be half a million pounds, and has declared that in general, cities have a choice between cheap electricity and smokeless generating stations.

One case of sulphur dioxide emission is illuminating. Although we are anxious to see the flue gases washed at all large installations of any kind, we recognize that some alleviation is attained if the chimneys are sufficiently high. This does not of course reduce the quantity of gases or fumes emitted, but it does assist their dispersal and dilution. The greater the size of an installation the more necessary is it for the chimneys to be of the maximum practicable height. In the case referred to there is a new generating station consuming 4,000 tons of coal a week and discharging into the atmosphere 23 tons of sulphur dioxide each day. No method of washing the flue gases has been installed, and the height of the chimneys is only 90 feet. It is reported that: "As the prevailing winds are south westerly, houses and allotments on the north-eastern side of the power station receive the fumes, which enter the houses and spoil growing crops. The fumes can be seen being carried by the wind in the direction of the houses and allotments."

It may be added that the height of the chimneys of the station is to be raised by an additional 70 feet.

Sulphur measurements by the lead peroxide method taken at three positions in the vicinity of this station, show moderate to heavy concentrations. It was noticed, from the records examined, that whereas for the months September, 1946, to February, 1947, the average SO_3 reading was 3.49 mg./100 sq.cm./day, the figure fell sharply for March and April, to an average of 2.10—a 40 per cent. decrease. This coincided with the supply of a better quality coal to the station, following correspondence between the local authority and the Ministry of Fuel and Power. Although the data available is perhaps not sufficient for drawing a firm conclusion, the sudden marked improvement is undeniably significant. It is, however, stated that quality of the coal being supplied is again deteriorating.

In view of the controversy over the proposed oil-burning power stations at Bankside, London, it is interesting to note that two of the generating station cases we have examined refer to the substitution of coal by oil. In one instance, complaints have been received about the emission of fumes when starting up the oil-burning furnaces at short notice on demand from the Central Electricity Board, but apart from these occasions the oil is preheated and nuisances are obviated. In the other case, the change-over from pulverised fuel to oil, at first led to an improvement, but there are occasions when trouble is experienced. This is thought to be due to technical difficulties or to negligent operation.

Gas Works

As only four cases of grit and fumes nuisances from gas works have been included in the record it is impossible to produce any statistics or make generalizations. Perhaps, however, the cases are typical of others that may exist. In one case, dust from the coke screening plant was the cause of the trouble, and was due to the defective condition of the dust-extracting plant. In another case, complaints regarding smoke, dirt and grit emission—the precise causes of which are not given—have completely ceased since flue gas washing plant was installed at a cost of £50,000.

The third case relates to smoke nuisance from the boiler chimney and of grit nuisance from an unenclosed coke conveyor. Informal action and visits by the Sanitary Inspector and the Regional Officer of the Ministry of Fuel and Power, together with the latter's "Stoker Demonstrator," have had excellent results in respect to the boiler emissions, while the grit nuisance has been effectively dealt with by enclosing the conveyor. The fourth case was again one of grit emission from the boilers, and of grit and dust from unenclosed elevators and fuel storage plant. Statutory notices were served requiring the installation of cyclone type grit arrestor and for the enclosure of plant, but the necessary materials have not yet been allocated. An improvement, thought to be due to the more careful supervision of operations, as a result of the local authority's action, is however reported.

ron and Steel Works

Five cases of emissions from iron and steel works are included in our list, and together form a, perhaps, typical cross-section of the causes of nuisances in the industry. The factors mentioned are as follows: (1) Blast furnaces (in three of the five examples); (2) Sulphur fumes from coke ovens; (3) grit emission from Bessemers; (4) a new technique in a modern blast furnace for reducing the sulphur content of the ore before it enters the furnaces; (5) grit emission from boiler furnaces at rolling mills. The emission from (4) is said to have had serious consequences in the district. In (5) the trouble, which arose from a new Lancashire boiler fired with pulverized fuel, has been abated by the provision of grit chambers with water sprays.

Other Cases

Other cases of grit and sulphur emission from the combustion of coal include collieries, clay and brick works, a paper and plaster board mill, and cement works. Sulphur emission from chemical processes is also recorded, including a case of the burning of a mixture of sodium bichromate and sulphur. There is also a case of dust emission on an apparently considerable scale from kilns, roasting magnesium ores and precipitates.

Finally, although it may not be strictly sulphur or grit, there are a growing number of references to smoke and fumes from burning colliery spoilbanks—*alias* pit heaps, tips or bings. In view of the fact that although the combustible material is necessarily carbonaceous, the main bulk of the material is inorganic mineral, it is possible that the sulphur content of the fumes is much higher than it is with ordinary coal smoke. It may, in fact, be more correct to classify this nuisance more as one of sulphur than of smoke. Experimental evidence on the composition of the gases, or perhaps sulphur estimations by the lead peroxide method taken immediately around burning spoilbanks, would be of considerable interest.

In conclusion, it will have been noted that little or no comment has been made on the facts reported. The survey, intended only to provide some evidence for the following papers and discussion, will be seen to be suggestive rather than complete. This is due to the fact that it has been prepared hurriedly, since the conference programme was agreed upon during the summer, and with only the limited material that was quickly obtainable. This did not permit making the full inquiry that can now be seen to be the essential preliminary of a fully informative inquiry. Whether such an inquiry, covering perhaps not only grit and sulphur, but all forms of pollution would be worthwhile, is a question that could be considered. A kind of "Atmospheric Pollution Census," covering the whole country, would undoubtedly give us material of great value, but it would entail a considerable amount of work, and would depend for its success on the response of the local authorities to whom it would have to be addressed, as well as upon the form of the inquiry and the way in which the facts elicited were analysed and tabulated. From such a census we might, for example, be able to obtain such information, as: (a) the extent of nuisances in specified industries and processes; (b) the nature of such nuisances; (c) their consequences; (d) the difficulties standing in the way of their abatement; and (e) data on remedial measures already taken.

Does the conference think that this idea, which is made purely speculatively, should have further consideration?

B1

Comments on the Present Position

By JAMES LAW *and* G. W. FARQUHARSON
on behalf of the Technical Committee

1. **Preamble.** Though it is not possible to obtain a true perspective of what is happening throughout the country with regard to the emission of grit and sulphur from industry, there are many features that can be shown which will perhaps give rise to a fair amount of discussion and some enlightenment on this subject.

There can be no doubt that this form of nuisance is on the increase, due to a variety of causes, and though remedial work can be suggested in most cases, it sometimes happens that the capital expenditure involved in such work renders it impracticable.

For many years the Department of Scientific and Industrial Research have been collecting from Local Authorities certain data with regard to solid matter deposited on selected sites, by the use of the Standard Deposit Gauge, but these records leave much to be desired, and even if a five year average of the records is taken, it only gives a poor indication of what is actually taking place in the vicinity.

All that can be said in favour of this method, is that it does not require a great amount of attention, it does give some indication of the types of pollution being deposited and until some better method is found, the Standard Deposit Gauge will continue to be used.

The introduction of the Lead Peroxide Gauge has been much more successful, and has given us a much better idea of sulphur determination by indicating the sources from which pollution can be caused.

In large industrial areas where factories are numerous, the damage caused to buildings and vegetation can be plainly observed.

Ironwork corrodes rapidly and privet and hawthorn hedges become blighted by the acidity. It has been stated that since the advent of coke oven plants in Yorkshire, ash and elm trees, which at one time grew in profusion, are gradually disappearing.

In close proximity to one large electricity generating station, there are about 300 allotment gardens and when the wind blows in an adverse direction, the path of the sulphur-laden gases can be plainly followed, as though a huge blow-lamp had burnt a path through the estate. Coping stones on the roof of buildings, when made of concrete, show rapid deterioration after 10 years in an acid atmosphere, whereas the natural stone is not so badly affected.

2. **Collieries, Coal Production and Coke Ovens.** It will be advisable to commence at the source where fuel is produced and note the difficulties that occur. Mechanisation at the coal face increases the amount of shale, bind and dirt sent to the surface. This calls for additional labour on the conveyor belts, where the coal is picked, and added load on the cleaning plant where de-dusting or washing is carried out. Fuels now being produced are showing much heavier ash content than when manual coal-getting was in operation.

The ideal method of cleaning coal would be a combination of de-dusting before wet-washing, thus removing much dirt and reducing the formation of "slurry."

Assurance has been given that the National Coal Board are giving the problem of dirty coal their most active and urgent attention and it will be interesting to watch these developments.

Part of the residual material is sent to the boiler-house and the remainder goes to the spoil-bank.

A colliery boiler-house is to all intents and purposes an "incinerator" where unmarketable fuels are disposed of. The fuels are low in calorific value, high in ash and moisture content. They vary considerably in size and composition, receiving many names such as "batts, belt pickings, dry fines, slurry, jubilee, washery settlings, etc."

Most collieries continue to use hand-fired Lancashire boilers, with varied methods of forced draught to assist combustion and increase evaporation. Steam demands fluctuate, forcing of fires takes place and the emission of grit in large quantities is common. No effort is made even to cyclone the flue gases in order to extract the coarser particles.

Material which cannot be utilized on the boilers as well as waste from the pit,

is deposited on the spoilbank, where the tendency to spontaneous combustion is prevalent, and when overheating occurs, it causes considerable discomfort and unpleasantness to the surrounding inhabitants from sulphur fumes.

During the war, the control of these spoilbanks was taken over by the Alkali Inspectors, and it was surprising to note the improvement made, but it is equally disappointing to note that many of them have deteriorated badly during the past two years, and it would appear that immediate action is necessary.

With regard to nuisance from Coke Oven Plants, only those who have to make frequent visits or are unfortunate enough to live in the vicinity have any conception of the amount of nuisance that is caused by sulphur-laden vapour and dust.

Generally, these plants are not installed in congested industrial areas and the dust and vapour has a better opportunity of dissipating over a wide area, but the nuisance caused is persistent.

3. **Gasworks,** particularly those of the older types, can be an abomination and as these are often sited in the most congested parts of industrial towns, much inconvenience and discomfort is caused by the emission of sulphur fumes and grit. Quenching of coke in large retort houses is almost continuous, and the grading and handling of coke, unless particular precautions are taken, causes grit deposit over a considerable area. The fuel used is small and during the winter months when winds are high and gusty it is common to see a dust cloud almost obscuring the gasworks.

4. **Boiler Houses.** The Ministry of Fuel and Power have advocated a general " degrading " policy in order to give a better distribution of supplies throughout industry, but much greater discrimination appears necessary with regard to boiler loads and conditions. Experience shows that small boilers with heavy steam demands are only given unscreened coal or even coke breeze and a proportion of the fuel is blown to the atmosphere unconsumed. In certain cases where coking stokers with natural draught were in operation for years, in order to use low grade fuel, the stokers have been removed and hand-firing with forced draught has been substituted, causing heavy grit nuisance.

Many of the " sprinkler " type mechanically fed boilers are now using small unscreened coal, and though with this type of stoker there has always been a tendency to deposit dust, this has become more aggravated. It has been found necessary to fit special cleaning doors on the side flues of boilers, so that they can be cleaned out each week-end in order to reduce the nuisance. Under normal working conditions these boilers were cleaned four times per year, at Easter, Whitsuntide, August and Christmas.

The quality of open-cast coal varies considerably and generally depends on the depth to which the seam is followed, the early excavated fuel having a low calorific value and a high ash content.

Open-cast coal output was about eight million tons in 1946, and the Ministry hope to increase the output by twenty per cent. this year, as more excavating machinery will be available.

5. **Iron and Steelworks.** As these are peculiar to certain isolated districts, the sulphur and grit nuisance is not so widespread, but it appears to be almost impossible to produce iron or steel without causing some nuisance from dust and sulphur.

In blast furnace practice, the handling of iron-ore, limestone and coke causes considerable nuisance. If you have any doubt in your mind, look at the pollution figures for Scunthorpe, where the refining of iron is intense.

Bessemer converters cause a heavy brown dust and heavy sulphur deposit as all impurity is blown to the atmosphere, very often at a low level.

Siemens open-hearth furnaces blow impurities to the atmosphere, and an amount of the dust is held in the chequer work, and the average chimney is about 200 feet high, so that deposits of dust and sulphur are not so noticeable as with the Bessemer process. Electric melting causes considerable dust nuisance from the impurity in the material and this is deposited at a low level.

Foundries and foundry cupolas are particularly bad sources of nuisance from sulphur and dust and as these are often sited in congested areas, they are a continuous source of nuisance. The carrying of the moulding sand causes nuisance, nauseous fumes are emitted from the baking of the cores, sulphur grit and paint fumes from the scrap metal are all emitted to the atmosphere at a low level. All foundry cupolas should be fitted with some form of arrester.

Perhaps one of the worst forms of nuisance is caused by abrasive dust from the grinding of ingots and billets. The

Factory Inspectors insist on an extractor for taking all dust from grinding wheels to the outside of the factory and in many cases no arrestment device is fitted to the effluent.

6. **Nuisance from Railways and Locomotives.** Grit and sulphur nuisance from locomotives on railways can cause considerable nuisance particularly in terminal towns or where the railway passes through congested areas in "cuttings" below ground level. At marshalling sidings where shunting is carried on almost continuously, the deposits of grit from locomotives are very pronounced. It is hoped that the electrification of railways will help to reduce the nuisance, though shunting operations will always be necessary, and these cannot very easily be carried out by electric tractors.

7. **Electricity Stations.** Last year at Brighton a resolution was passed viewing with grave concern the menace to health and amenities caused by the emission of smoke, sulphur and grit from certain electricity generating stations and calling upon the Ministry of Fuel and Power and the Central Electricity Board to take immediate steps to obviate the nuisance.

The original resolution asked "that all future installations shall have suitable gas washing plant installed as part of such installations" and this is a matter that must be strongly emphasized.

Little can be done to minimize nuisance on existing boilers and remedial work must be considered as a palliative rather than a cure.

Any effective prevention that is to take place must be included as part of the design of the boilers, before they are installed.

It is estimated that it will be three years before sufficient power station capacity can be made available to overcome the present shortage.

The recent announcement by the Ministry of Supply that £75,000,000 is to be spent on building and civil engineering work, on electric power stations to help bridge the gap, bear out this estimation. The projects which are part of a continuous programme are for new stations and extensions to existing power stations.

Enquiries regarding a few of the new power stations in the course of planning or construction indicate that the application of dust extraction plant is being catered for, but flue gas washing is not being considered as an immediate necessity the reason for this being additional cost and the coal to be used will have a low sulphur content. Coal, however, is far from being a standardized product, and all local authorities in whose area new power stations are to be sited, or ready in construction are urged to install atmospheric pollution recording apparatus, so that records can be made, which will be available for future comparison.

It is interesting to recall the official figures given for the year 1938, in relation to the washing of flue gases at the London Power Company's station at Battersea, and the Corporation Station at Fulham.

In both cases instruments were in use for automatically testing and recording the acidity of the flue gases, the figures being as follows:

London Power Company—Battersea.

Total weight of coal fired	465,152	tons
Average sulphur content of coal	0.88%	
Equivalent of sulphur eliminated by gas washing	3,683	tons

Fulham Corporation Power Station.

Total weight of coal fired	413,591	tons
Average sulphur content of coal	0.875%	
Equivalent of sulphur eliminated by gas washing	3,517	tons

For many years the Smoke Abatement Society has advocated the more extensive use of electricity in order to improve the atmosphere of our towns and cities, but the question now arises whether the more extensive use of electricity is to be carried out at the expense of grit and sulphurous fumes nuisance to the public in the vicinity of the power stations?

8. **Conclusions**

(*a*) *Fuel Supplies* should be more uniform in their grading if satisfactory results are to be achieved and any reduction made in the deposit of grit.

(*b*) *Nuisance from Coke Ovens and Gas Works* require some further legislation, whether they are to be dealt with by Local Authorities or the Ministry of Health.

(*c*) *Colliery boilers and Spoilbanks* can be dealt with by existing legislation and immediate action should be taken with the National Coal Board.

If resolutions are made, after submission to the appropriate Government Department or Corporate Body concerned, they should be persisted with until some satisfactory solution is put into operation.

(*d*) *Iron and Steelworks* should have

efficient dust arrestment devices fitted to processes where it is known that excessive emissions occur, and especially with regard to Bessemer Process effluents and foundry cupolas.

(e) *Electricity Power Stations.* It is understood that the resolution passed at Brighton last year did not receive the attention from the Central Electricity Board that was hoped for. It is thought that a further resolution should be sent from this Conference as follows :

"That this Conference of the National Smoke Abatement Society views with grave concern the menace to health and amenities caused by the emission of sulphur and grit from Electricity Power Stations and calls upon the Ministry of Fuel and Power and the Central Electricity Board to take immediate steps to obviate these nuisances by ensuring that *all future installations* shall have suitable flue gas washing plant installed, as part of such installations."

Progress in Dust and Sulphur Oxide Removal

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during the past decade and review of future possibilities

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1.0 Introduction

1.1 *Previous Papers*

An excellent paper was given in 1936 to the Society by A.T. Barber and T. F. Hurley, entitled "A review of Methods for the Prevention of Grit and Dust Emission." This described in detail the following equipment, giving at the same time the basic theory underlying their design.

Dry Types:
- Settling Chambers
- Centrifugal Separators such as Cyclones
- Electrostatic Precipitators

Wet Types:
- Modave Film Type Dedusters
- London Power Co. System for Washing Sulphur from flue gases (as installed at Battersea Power Station).
- Howden—I.C.I. System for Dust and Sulphur Oxide Removal (as installed at Fulham Power Station).

1.2 *Scope of Present Paper*

The present paper will not go over the same ground again, but will be confined to a statement of progress since 1936. Readers who are not familiar with the general principles of design of the forms of equipment mentioned are therefore referred to the Proceedings of the 1936 Conference of the Society.

As regards dust elimination, most of the review given will be concerned with dust arising from pulverized fuel firing, partly because plant which is satisfactory for removal of such dust will, in general, be satisfactory for other duties such as dust from cement kilns and metallurgical furnaces, and partly because the tonnages

of dust involved are far and away greater than that from any other process.

Before passing to detailed remarks on improvements in equipment, however, some attention will be given to the more general aspects of dust emission as affecting atmospheric pollution.

2.0 Pulverized Fuel Conference

2.1 During June of this year, the Institute of Fuel held in Harrogate a Conference on "Pulverized Fuel." Of the 55 papers given to the Conference four were full-length papers on dust collection, another five mentioned the difficulties of collection, and one dealt with the dispersal of gases and dust from high chimneys.

In the Chairman's summaries of the work of the Conference, emphasis was laid on the amount of time spent in discussion on dust collection. Members of the Smoke Abatement Conference may therefore rest assured that technologists, not only in this country but in the U.S.A. and Europe, are constantly working to improve existing methods and devise new ones.

2.2 *Growth in Use of Pulverized Fuel*

The need for research on improvements, and equally important, the need for industrial development of the research results, is shown by the following figures for the consumption of pulverized fuel.[1]

Consumption of Pulverized Fuel—Millions of tons/year

Year	1930	1935	1945	*Estimate for* 1950
For steam raising	1.67	3.15	5.97	11.5
For other processes ... (e.g. cement, metallurgical)	1.43	1.95	2.87	3.5
Total	3.10	5.10	8.84	15.0

2.3 *Advantages of P.F. for Boilers*

The reasons for the growth in the uses of pulverized fuel for firing boilers are:

The higher efficiency obtainable.

The flexibility of the system and ease of control, especially for two-shift power stations.

The ease with which low-grade coals can be burnt (especially fines) when they are dry.

The ability of the system to cope almost instantaneously with variations in ash content of the coal.

The greater freedom of pulverized fuel boiler furnaces from slag and other adhesions to the boiler, economiser and air heater surfaces. This means that the boilers can be run longer periods without being shut down for cleaning than boilers equipped with mechanical grates. Hence, P.F. boilers have a greater useful service period per year—a point of great importance at the moment when there is such a shortage of boiler capacity for producing electric power.

The freedom from mechanical difficulties when P.F. is used rather than mechanical stokers for the very large boilers now being built for central power stations.

It follows that P.F. firing will be adopted to a much larger extent than previously for all public supply power stations and probably also in industrial boiler plants, especially at collieries. Even by 1939, nearly one-third of the large boilers in power stations were fired by P.F.

In the U.S.A. it is recorded that 87 per cent. of the new power station boilers will be fired by powdered fuel.

2.4 *Developments in Preventing Production of Dust from Coal Fired Furnaces.*

Nevertheless, combustion engineers are constantly searching for methods of burning fine coal without the production of fine ash, which is so expensive to remove from the flue gases. In the U.S.A. a few P.F. boiler furnaces have been designed in which the temperature is so high that a large proportion of the ash is melted in the combustion chamber and runs from it in molten form. These "slag tap" furnaces collect a bigger proportion of dust (40-60 per cent.) in the combustion chamber than conventional P.F. furnaces (20-30 per cent.) and thus pass out less dust to the dust collectors. It is doubtful, however, whether slag tap furnaces can be used

[1] P.A.H. Elliott—Papers to Institute of Fuel Conference on P.F., 1947, p.419).

with British coals as, in general, the melting points of the ash in this country are higher than in the U.S.A.

A more recent development, still in the pilot plant stage, is the "cyclone furnace" in which the coal is only coarsely ground. It is claimed that only 10 per cent. of the total ash in coal passes out to the dust collectors from boilers with these furnaces, partly because the ash is melted and partly because the coal is not finely ground.

3.0 Intermediate Problems on Dust Removal

3.1 From what has been said above, it will be seen that the big problem of atmospheric pollution *today* is the collection of dust from powdered fuel boilers

3.2 *Cost*

Research is needed not only on improved efficiencies, but on cheaper methods of dust collection. Thus, Dr. P. O. Rosin has stated that with present-day good standards of efficiency, the cost of cleaning the flue gas from P.F. boilers may add as much as 5 per cent. to the cost of steam and has in some cases destroyed the advantages of P.F. firing. (Ref. 2). The capital cost of high-efficiency electrostatic precipitators is about 10 per cent. of the cost of a complete high-pressure boiler plant, and the ground area covered by the precipitators may even be greater than that of the boiler.[2]

3.3 *Disposal of Collected Dust*

A subsidiary problem is the disposal of the collected dust. It is calculated that there will be two million tons of it collected per year after 1950. It is no good wetting it and putting it on dumps where it can dry out and then be blown about the country-side. Really satisfactory uses for the dust have yet to be found, though some experiments on its use for making building blocks are promising.

4.0 Performance required of Dust Collecting Plant

4.1 Theorectically it is possible to free any gas completely from dust. In practice, the volume of flue gases from boiler and other furnaces is so huge that size of plant and its auxiliaries and their cost become the governing factors in the choice of design for a dust-collecting system. Guidance on a commercially attainable performance for public utility power stations has, however, been given during the past 10 years by the Electricity Commissioners who recommend designers to specify that the dust leaving the chimneys should not exceed 0.4 grains per cubic foot at N.T.P., and that not more than 0.15 grains/ft.3 should exceed 20 microns (0.02 millimetres) in diameter. It will be noted that the Electricity Commissioners do not concern themselves directly with collector efficiency, but the higher the dust concentration of the gas entering the dust collector, the higher the efficiency required. It will also be noted that they set a more stringent limit for coarser dust or grit.

For discussion of the merits of these recommendations, members should refer to Mr. Humphrey's paper given to the Society in 1946.[3]

As far as is known, Britain is the first country in the world where definite voluntary limits for concentrations in dust emission are set—these limits are set by the electricity industry and not by the law, and can therefore be changed without delay should the appropriate circmustances arise.

4.2 *Methods of Test of Dust Collectors*

It is imperative that the performance of a dust-collecting plant be measured not only to check that a good piece of equipment has been purchased, but to check that its performance has not changed with use. It is also valuable to be able to check the performance of a plant immediately any complaint is raised of an increase in dust fall in the neighbourhood.

In 1940, the British Standards Institution issued a specification (BS 893) on "The Testing of Dust Extraction Plant and Dust Emission from Chimneys of Electric Power Stations." The method enables tests to be made from the exits o dust collectors to determine whether they conform to the Electricity Commissioners' recommendations. The method is, however, so cumbersome and requires such specialized equipment, that it can generally only be carried out by the manufacturers of equipment or by very large power station organisations. It is therefore pleasing to report that the Committee which prepared this specification is now working on the design of simpler equipment, a requirement also mentioned by Mr. Humphrey.

During the past decade, there have also been developed electrical smoke density

[2] P.O. Rosin—Papers to Institute of Fuel Conference on P.F., 1947, page 40.

[3] H.A. Humphrey Proc. Nat. Smoke Abatement Society Brighton. 1946 page 40.

meters, which measure the opacity of the smoke in a flue to light. Such devices are primarily of use in determining whether black or dark smoke is being made, but they are also finding increasing application in plants such as stoker and P.F. boilers, where dark smoke is not made and the dust is of uniform colour and size ; they then give a rough measure of the dust concentration (but only if the colour and size distribution of the dust remain constant) and so are useful for recording when a plant is in bad adjustment.

4.3 *Dispersal of Dusty Flue Gases from High Chimneys*

Since all the dust cannot be removed from flue gases, much thought has been given to the dispersal of fine air-borne dust, and of gases from chimneys. The latest conclusions were given by Professor Brunt to the P.F. Conference.[4] He concluded that chimneys of central power stations should discharge at a level where the air is seldom stagnant, which he gives as 300-350 ft. above ground, depending on the quantity of dust and gas to be dispersed. He also draws attention to the undesirability of placing power stations in valleys where there is a danger on clear nights of the formation of a pool of stagnant air above which the chimney emissions may never rise—in fact, power stations should be built in breezy situations. His general conclusions are very similar to those given in Mr. Humphrey's paper last year. (Ref. 3).

5.0 Improvements in Dust Collecting Devices

5.1 In the preceding section, a review of the progress on the general problem has been given in order to emphasise that sources, quantities and measurement of quantities are as important as mere removal of dust once produced—in addition, a short account has been given of the attempts to reduce dust at its source by development of special furnaces.

In this section a review will be given of the progress with individual types of equipment in common use. Apart from improvements in detail little progress has been made except in the development of cyclones.[5] This applies not only to this country, but also to the U.S.A. and Germany.

5.2 *Cyclones*

In a cyclone, the gas is caused to travel in a spiral band and in this spiral, the dust is thrown by centrifugal force to the outside. In the conventional cyclone, the spiral path of the gas is also downwards into a conical hopper at the base of the cyclone where the dust falls out whilst the clean gas goes out through a pipe drawing it off from the centre of the vessel.

The pre-war design of cyclone had an efficiency of about 70 per cent. with the fine dust from pulverized fuel boilers. Hence, though cyclones were extensively used for removing grit from the flue gases of boilers with mechanical grates, they were not good enough as collectors for large pulverized fuel boiler plants.

The reasons for the inefficiency of cyclones are :

(*a*) The difficulty of preventing re-entrainment of dust from the wall side of the cyclone into the central core of cleaned gas going to the exit.

(*b*) The large centrifugal forces required to spin the finer particles of dust to the outside edge of the gas spiral.

(*c*) The time taken for a particle of dust to travel from the inside edge of the incoming spiral band of gas to the wall of the cyclone.

(*d*) Limitations of draught loss which prevent use of very high speeds of gas whirl. In practice, excessive speeds also favour eddies which give re-entrainment.

It is apparent from these considerations, which can be expressed mathematically, that smaller cyclones will always be more efficient for any given gas entry speed. In fact, for the fine dust emitted from P.F. installations, the cyclones would have to be 6 inches or less in diameter to give an exit dust concentration less than 0.4 grains/ft.3 at N.T.P. The pre-war boiler plants had 6 or 8 cyclones in parallel, each of 6ft. diameter. With cyclones only 6 inches in diameter, several hundred are required per boiler. The problem is to design a system in which equal quantities of gas are passed through each cyclone. This problem has now been solved by placing the cyclones in banks side by side in a large chamber and carefully balancing the pressures in the inlet and exit parts of the chamber and in the common dust hopper.

[4] D. Brunt : Dispersal of Gases and Dust from Tall Chimneys—Papers to Institute of Fuel Conference on Pulverized Fuel 1947, page 339.

[5] J. E. O'Breen : Dust Recovery—Papers to Inst. of Fuel Conference on P.F. page 874. Leonard Lee : Dust Extraction applied to Combustion of Pulverized Coal. *Ibid.* page 612.

This form of design has raised the efficiency of cyclones on P.F. flue gas, from about 70 per cent. to 85-90 per cent., but it is still not good enough when the proportion of ash leaving the combustion chamber is high, especially when the ash content of the coal is also high.

5.3 *Cyclones with Skimming Devices; Two Stage Systems*

The particles which reach the edge of the spiral band of gas in a cylone are apt to be thrown back into the gas stream by bouncing from the walls of the vessel. The result in practice is that there is a thin band of gas spinning along round the wall of a cyclone which contains a higher proportion of dust than that in the centre of the gas stream. By placing a dip pipe into the top exit of a cyclone, it is possible, therefore, to draw off clean gas from the centre and rather dirty gas from the part near the walls (whilst the main bulk of dust is still thrown down to the bottom of the cyclone out of the swirl and into a dust hopper). The dirtier gas can then be pulled by a fan through a second dust collector and given a further purification. This is the latest development—see Figure A. The quantity of gas taken to the secondary collector is usually 20 to 25 per cent. of the total.

In plants where the second purifier is a cyclone, efficiencies of 90 to 95 per cent. have been claimed, as at Peterborough Power Station. In some plants in the U.S.A., the second purifier is an electrostatic precipitator, and efficiencies of over 95 per cent. have been reported. (See also 5.5).

The multi-cyclone system has already become competitive in efficiency and cost with the electrostatic plants installed before the war, and size for size (that is volume occupied) is more efficient. It has unfortunately a substantially greater draught loss, but only about three-quarters of that of a large diameter cyclone stystem.

It must not, however, be concluded that there now exists on the market a finished type of design which will satisfy the requirements of all processess and of all design and operating engineers. The development is new: there are few plants of this type in the world at present and these are, it is believed, all on boiler plants. Troubles have occurred with chokage of the small individual cyclones (probably when they were cooled below the dewpoint of the gases) and with corrosion and erosion. Erosion should, however, be less severe with small diameter cyclones than with large, as the

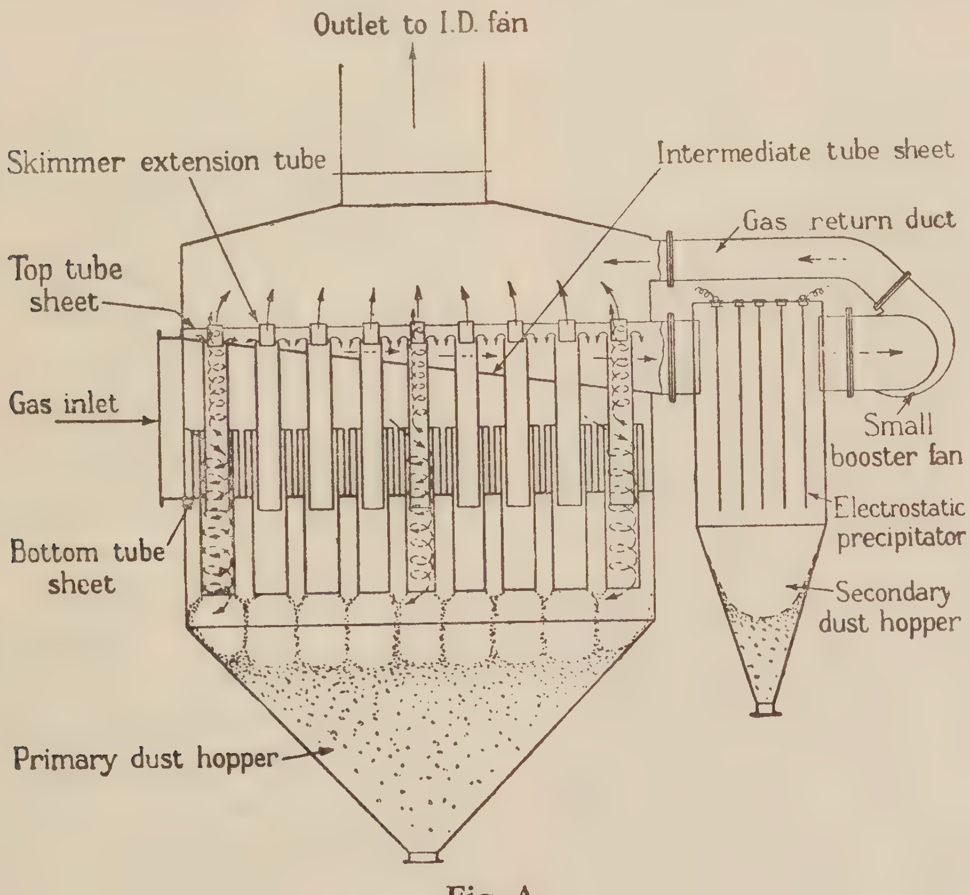

Fig. A.

gas velocities are lower than in large diameter cyclones.

5.4 *Electrostatic Precipitators*

Until the devolpment of the multi-cyclone, electrostatic precipitators were the favoured equipment for the removal of dust from cement plants and from P.F. boilers. Efficiencies of over 95 per cent. can be obtained—at a cost.

During the past ten years, no major developments have taken place, but there have been many improvements in points of engineering detail such as electrode wire supports, shape of electrode, rapping gear for detaching the collected dust. The problem of securing really uniform distribution of gas (and uniform distribution of dust in the gas) to all the banks of plates or tubes in a collector has not, in the author's view, been solved, and much still remains to be done to prevent re-entrainment of the collected dust into the gas stream.

One obvious difference between electro-precipitators built ten years ago and now, is in size. This is because engineers are tending to ask for higher extraction efficiencies, not only because the dust content has increased with the increased ash in coal, but also because it is realised that, with very large power stations, it is necessary to design for an exit test below the recommended 0.4 grains/ft.3 in order to achieve this figure day in and day out under commercial operating conditions (as opposed to test conditions when the plant is new).

It has been found that the ordinary design of precipitator has a low-collecting efficiency for ash particles high in carbon content (say over 30 per cent.), such as the dust left from the combustion of anthracite. This is because particles high in carbon lose their charge rapidly when they reach the collecting electrode and may even become oppositely charged and consequently be repelled. Just before the war, pilot plant experiments were carried out at Swansea to develop a design for high carbon dusts.[6]

Special collecting electrodes with pockets were evolved for the purpose of collecting the particles of high carbon content as soon as they reached the discharge electrode. The collecting electrodes were also arranged in two banks in series and a lower voltage (40-45,000 volts) was used on the inlet bank, compared with the exit bank (45-50,000 volts). This is because the high dust concentration was apt to cause "flash-overs" in the inlet bank if the voltage was too high, but a high voltage for final cleansing was permissible for the second stage where the gas had already been partly cleansed. These improvements were incorporated in a successful full-scale plant which gave an exit test even under adverse conditions of 0.28 grains/ft.3, corresponding to an efficiency of 96.5 per cent.

It was evident from the discussion on the paper describing this work that much research is still required on the mechanism of collection in a full-scale precipitator, on the form of electrodes and on the best wave form of the rectified high-tension current.

5.5 *Combination of Cyclone and Precipitator*

Owing to the large size of electrostatic precipitators, their high capital cost and the difficulties experienced in trapping dust particles of high carbon content (which are usually realtively coarse), opinion in the electrical industry, as expressed at several discussions on technical papers, is veering in favour of a combination of cyclones followed by electrostatics precipitators—in particular of a combination of nests of small diameter cyclores with bleed off at 15-25 per cent. of the exit gas from the exit wall of the cyclone to a small electrostatic precipitator (See 5.3). Such a system should ensure that all coarse grit, such as that emitted during soot-blowing, is collected by the cyclone, and that the fines, already concentrated by the cyclone, are adequately caught by the electrostatic precipitators. There seems no reason why this system should not ultimately be developed to give exit dust concentrations which, when discharged up a suitably high chimney, will be quite free from complaint from both near and distant neighbours, thereby satisfying the stringent apsirations of this Society.

5.6 *Film Washers*

The Modave Dust Arrester is the principal example of a type of dust collector in which the dust is removed by impingement on specially shaped vertical tubes down the outside of which flow films of water. In the latest plants attached to P.F. boilers, efficiencies of over 92 per cent. are claimed where sufficient rows of elements are used. Although the plant also removes about 25 per cent. of the sulpur oxides from

[6] J. Bruce: Electrostatic Precipitation of Dust from Boiler Flue Gases — J.Inst.E1.Engs. Vol. 92, pages 58 and 326 (194-5). See also H. W. Wagner: Papers to Inst. of Fuel P. F. Conference 1947, page 65.

the gases, it has the major disadvantage that large volumes of water are used with the result that large settling ponds are required for the removal of the collected dust before the water can be discharged to drain. If it is required to recirculate the water, lime addition is necessary to neutralise the absorbed acid and elaborate precautions have to be taken to prevent growth of chemcial scale on the elements.

5.7 *Combination of Spray and Film Washers*

An interesting development of a Modave system was described in discussion at the Institute of Fuel P.F. Conference. After many experiments, the water normally used on the elements has all been diverted to pressure sprays delivering into the large existing chamber which connects the air heater with the Modave deduster. The Modave elements have been reduced from 6 to 4 rows and now serve mainly as spray arresters (but as they are wetted they still function as final dust collectors as well). The result has been that the efficiency of the equipment has been increased from 88 to 95 per cent. and the dust content of the gases going up the chimneys is now below 0.22 grains/ft.3 at N.T.P. It was, of course, necessary to line the spray chamber with acid-resisting brick, especially as the extraction of sulphur oxides was increased from 25 to 30 per cent. The process has the disadvantage that it cools the gases down to 110 deg. F. (previously 160 deg. F.) and consequently the thermal uplift from the chimneys is decreased. The system is not of general applicability as there are few power stations with sufficient supplies of river water for the process.

6.0 Improvements in Sulphur Oxide Removal

6.1 *Performance of Existing Plants*

Both the Battersea and the Fulham plants (which were designed for almost complete removal of dust and sulphur oxides) have been run since the 1936 review to the Conference, but, as most members know, they were shut down in 1940 because the plumes of steamy vapour from the chimneys enabled the power stations to be picked out by enemy aircraft.

Dust removal was so good that the ordinary methods of test are of little value—the proof of high-dust removal efficiency was that the plume of steamy vapour from the chimneys rapidly dissipated, leaving no visible " smoke " at all. This was the case also at a plant installed on pulverized fuel boilers at Swansea.

The remarkably high preformance on sulphur removal is shown by the following figures quoted by the Chief Alkali Inspector in his annual report for 1937.

	Battersea	*Fulham*
Specified exit test in grains S/ft.^{3} at N.T.P.	Best practicable	0.03 (95.5% efficiency)
Av. of works tests	0.032	0.0063
No. of tests	879	700

It is of interest to record also that during the war a single unit was installed at Rochester to remove dust, oxides of sulphur and hydrofluoric acid from a process in which rock phosphate was roasted with soda to prepare fertilizer. The efficiencies required were 96 per cent S removal and 97 per cent. H.F. removal and were achieved comfortably—dust removal was 93 per cent.

These figures are so good that it is not surprising that no improvements in efficiency have been made since the processes were installed. Had it not been for the war, there is no doubt that some attempts would have been made to reduce the cost of the process (which is about 4s. per tons of 1 per cent. S coal burnt on present-day prices for a non-effluent system, such as that at Fulham, where there is no discharge of used wash liquor to the river, it rises to 7s. when the sulphur is 3 per cent.).

6.2 *Recovery of Sulphur Oxides from Boiler Flue Gases*

Nevertheless, it is difficult to see how the cost of the process can be reduced substantially as long as the sulphur oxides are neutralized with chalk or lime, the cheapest forms of neutralizing agents available. The by-product, gypsum, is contaminated with ash and is of so little value that it does not pay to dry and sell it. Use of ammonia instead of lime has been suggested so that useful ammonium sulphate is produced. It is

again doubtful if this would cheapen the overall cost to the power stations.

The alternative is to recover the sulphur oxides as such. Several such systems of recovery were studied before the war in some considerable detail by by H. F. Johnstone in the U.S.A. In the latest of them[7] the sulphur dioxide is scrubbed out by a solution of sodium sulphite, thereby forming sodium bi-sulphite. The bi-sulphite solution is then filtered free of ash and treated with zinc oxide powder, whereby zinc sulphite is precipitated and filtered off, leaving the original sodium sulphite solution regenerated for use again in the flue gas scrubber. The zinc sulphite is then dried and roasted in a flash calciner, heated externally by oil to about 550 deg. F. The sulphur oxides are then given off and the zinc oxide is regenerated for return to the second part of the process. The sulphur dioxide, which is nearly pure, is cooled, compressed and condensed as liquid for sale. Johnstone had in mind the sale of the sulphur dioxide for manufacture of paper from wood by the sulphite process or for manufacture of sulphuric acid.

Although this very thorough piece of research was completed in 1940, there have been no reports of projected full-scale developments, and it must be suspected that the cost of such a complicated process outweighs the sale value of the product, especially as sulphur is relatively cheap in the U.S.A.

So far, the U.S.A. is not fully conscious politically of the damage and nuisance from the sulphur oxides emitted from large power stations in the centre of cities, although the sulphur content of Mid-West coals is 4 per cent. and over. The P.F. Conference was, however, told by a visiting American that he expected steps to be taken in the near future by local authorities to have the sulphur oxides removed, at least in part.

[7] H. F. Johnstone and A. D. Singh: "The Recovery of Sulphur Dioxide from Dilute Waste Gases by Chemical Regeneration": University of Illinois Bulletin No. 324 (1940).

6.3 *Sulphur Removal at New Power Stations*

Consent for the new power station (oil burning) at Bankside has been given with the proviso that oxides of sulphur are to be removed. This is all the more necessary as fuel oils from some sources contain over 3 per cent. of the sulphur; taking into account the higher calorific value of oil, however, this is equivalent to firing coal of 2 per cent. sulphur content.

Although sulphur oxide removal has not been required at other new power stations, the condition has been imposed in the case of the larger stations that space be left for sulphur oxide removal plant should it later be required.

7.0 Conclusion

Despite the intervention of the war years, the period under review has been one of steady development of ideas on dust and sulphur oxide removal. We have seen the fine performance of the Battersea and Fulham plants, and we have seen the development of small-diameter cyclones to the large-plant scale. In addition, there is now a greater appreciation of the performance required of dust collectors to reduce atmospheric pollution and a greater appreciation of the gaps in knowledge of the science or art of dust collection; in addition, active work is proceeding on the development of methods of firing coal which, whilst having the advantages of pulverized fuel firing, do not produce such a high dust burden to be removed from the final flue gases.

Discussion

Dr. R. Lessing (London) wrote to say that professional engagements made it impossible for him to attend the Conference, particularly as in his capacity of Chairman of the Technical Committee he had been looking forward to hearing the discussion of the papers sponsored by that Committee. The papers submitted by Messrs. Silver and Marsh and Messrs. Law and Farquharson furnished ample proof of two points: (1) that the formation of a technical committee of the Society was fully just fied and was in fact, long overdue, and (2) that the Committee was faced with a heavy task if it was to cover the immense field adequately.

The papers must be regarded as a modest attempt at collecting typical examples of the various kinds of atmospheric pollution, but these examples were telling enough to demonstrate the seriousness of the situation. Whilst they showed a qualitative cross section

of the offending contributors to the nuisance, they also pointed to the need for a more quantitative study of the problem. The Technical Committee aimed at formulating a programme for the investigation of the sources of atmospheric pollution as distinct from the assessment of rates of deposition of solid matter from, and the presence of sulphur in, the air, which had been the concern of the Atmospheric Pollution Committee of the D.S.I.R. for many years. The first stage of this investigation would have to take the form of a survey such as was recommended in the paper he had the honour of submitting to the Society at the Bristol Conference in 1935. The organization of such a survey would be beyond the resources of the National Smoke Abatement Society as at present constituted, but we should be quite able, with the co-operation of all those willing and competent to help, to prepare a plan of operations and lay the foundation upon which the work could be firmly established.

Dr. Lessing's insistence on a comprehensive survey of the pollution of the air must not be understood to be dictated by any uncertainty regarding its final outcome. Many years of study of individual cases and practical—and he might be permitted to add, successful—work in preventing or curing the evil, had convinced him of its magnitude. But he was also alive to the need for bringing home to the people, the industrialists and above all the Government, uncontrovertible facts and figures which would break down the ignorance and apathy of those who possess the means and the power of abolishing the evil, and rouse them to action in the fight for clean air.

The technical means were available, as shown by the paper by Mr. Nonhebel which gave a useful summary of the present state of the art of eliminating dust, grit and sulphur oxides from combustion gases. The Society's object must be to see them applied. Dr. Lessing stressed that there must be no delay as we were now embarking on an era of industrial reconstruction and any shortcomings in planning this work would postpone the betterment for a generation or more. Immediate efforts should be concentrated on two factors which touched the crux of the pollution problem to-day. These were: (1) the natural dust in coal and (2) the sulphur acids formed on combustion.

(1) "Natural Dust," which he had defined as that fraction of raw coal which consisted of particles smaller than one-hundredth of an inch (0.25 mm.) was produced in the normal course of mining and handling in proportions not exceeding 5 per cent. of the whole seam. It differed from the bulk in its main characteristics, was very friable, generally non-coking and the chemical composition of its ash distinguished it from the other coal components. It was this small portion of the coal which formed most of the grit, dust and fly-ash in the chimney gases. It was blown from the fuel bed by these gases, much of it before it was completely burned, with consequent fuel wastage. Recent tests at a power station confirmed that an increase of "natural dust" in the coal from 2.5 to 5.0 per cent. caused the dust and grit emission also to be doubled. He said he had shown the technical and economic advantages of "de-dusting" coal at the colliery in a paper given before the Pulverized Fuel Conference at Harrogate (June, 1947) and he suggested that representations should be made to the appropriate authorities to enforce the adoption of this simple expedient for disposing of much of the dust and grit nuisance, and incidentally saving several million tons of fuel a year which was now wasted.

(2) The discharge of sulphur oxides into the atmosphere called for different considerations. Coal, even if thoroughly cleaned, contained sulphur in organic combination which was released on burning in the form of acid compounds. A large power station discharged the equivalent of more than 100 tons of sulphuric acid a day. This was not visible and did not offend the eye like grit and dust, but its effects were much more damaging to buildings, metals, textiles and vegetation than those of the solid deposits. It was the more insidious enemy as it might take years before the damage became apparent, but this rate would be hastened by the operations of the numerous new power stations about to be erected. The concentration of acid emission from those point sources rendered the installation of effective means for sulphur oxide elimination imperative.

High chimneys might give some local amelioration, but they did not solve the problem. The acids must and would find matter for their neutralization further afield. An instructive example was the formation of basic sulphates on copper roofs which even if situated in

rural surroundings were turned green on the side exposed to the prevailing wind if this had passed over an industrial town which might be many miles away. Whilst this formation of patine might be quite desirable from an architect's point of view, it served as an indicator of damage done to other materials by sulphur acids.

Dr. Lessing concluded by saying that the removal of sulphur oxides from flue gases should be demanded by the Society with no less vigour than that of the elimination of dust and grit.

A. N. East (Electricity Commission) drew attention to the resolution in concluding the paragraph of the paper by Messrs. Law and Farquharson. He said that there was nothing in the evidence presented in that paper, or the one by Messrs. Silver and Marsh, to justify it. Messrs. Silver and Marsh had quoted 15 generating stations as having been the cause of complaints though the authors had considerably modified this by adding that the reports were not very definite. Even if all these 15 cases were proved they represented about 4 per cent. of the 350 public generating stations in the country, which was scarcely sufficient reason to call for universal gas-washing. Mr. East then pointed out that no mention had been made of the expenditure necessary to carry out this proposal and suggested that to make the resolution reflect the mind of proposers it should have added to it the words "Regardless of cost." Mr. Nonhebel had stated in his paper the cost of gas washing at Fulham was 7s. per ton of coal consumed. This process was the only one generally applicable due to the lack of large quantities of water, such as were available at Battersea, thus, allowing for the rise in cost since the war, the probable figure might be 10s. per ton of coal consumed. With coal at 50s. this represented an increase in fuel cost of 20 per cent. If therefore, the Society considered the resolution (as amended by him) should be accepted they should add a rider to the effect that they were unanimously agreed to pay any increased charges, whether for industrial or domestic supplies, consequent upon the terms of the resolution being put into practice. He expressed the hope that any investigations in grit and sulphur deposits would be carried out under the direct guidance of the D.S.I.R. and not left to the enthusiasm of individual local authorities.

In conclusion he suggested that, in place of the resolution referred to, the Conference could do far more to eliminate grit if they called upon the Minister of Health to require all industrial consumers of solid fuel to install grit extraction equipment which more nearly approached the standard of performance already obtaining at public utility generating stations.

John Roberts (Severn Valley Gas Corporation, Ltd.) offered a friendly word of advice to Messrs. Law and Farquharson who had described gasworks as abominations. His advice was that they should not antagonise their best friends, as the carbonizing industries carbonized over 40 million tons of coal per annum, thus extracting over 10 million tons of potential smoke from the coal they used. Admittedly some smoke was made in the retort house, but someone had to do a dirty job; someone had to be a scavenger, and the gas industry was engaged in scavenging filth from the atmosphere, and for that reason he was proud to belong to the industry. Their factories, therefore, should not be described as abominations.

E. James (Dartford R.D.C) drew the attention of the Conference to page 77 of the Survey made by Mr. Silver and Mr. Marsh. In the paragraph "Other Cases" mention was made of "Cement Works" in which certain investigations were made. Mr. James said he represented a Rural District in North West Kent which had a number of large cement works on the Thames-side part of the district. There were also cement works in adjoining areas and all these works polluted the surrounding area with dust emitted from their chimneys. He said it would not be an exaggeration—in fact, it would be an understatement—to say the dust extended for an area of six miles from the factory. It is a nuisance which was so serious in the locality where there were a large number of hospitals as well as fruit growing agricultural land.

Mr. James said it was interesting to note that in the 82nd Report on Alkali Etc. Works by the Chief Inspectors of the Ministry of Health, 1939-45, page 16, it was stated that: "In the Thames-side district, the scale of cement production is so great that conditions have not been completely satisfactory in spite of every effort." It was incorrect to say that it has not been completely satisfactory in spite of every effort. It had never been satisfactory. The Report continued:

"In view of complaints made to him in 1943, the Minister of Health ordered a special investigation by two medical officers who came to the conclusion that although the deposition of dust was undoubtedly a great nuisance, yet there was no evidence that it caused damage to health."

The Local Authority he represented were convening a Conference of all Local Authorities in North-West Kent affected by this problem and were including the Medical Profession, Chambers of Commerce, Trade Councils and the National Farmers' Union to see if some positive action could be taken to abate the nuisance.

Mr. James suggested that this was an opportunity for the Society to give a particular problem the further consideration referred to in the final paragraph of the Survey with the object of trying to obtain the information there suggested and to ascertain the difficulties standing in the way of remedial action of a nuisance which had been going on for years. He concluded by saying that it was a typical case where the detailed investigations suggested in the Survey could be carried out.

Councillor S. Scott (Dartford Borough) speaking in support of Mr. James, Clerk to Dartford Rural District Council, said that in Dartford the Borough Council were building a housing estate of approximately 2,000 houses as a complete self-contained community, the houses being "all electric" and fitted with up-to-date labour-saving appliances, and that they were also investigating the possibilities of a district heating scheme, but all the benefits which could accrue from such planning would be lost unless the cement dust nuisance could be eliminated. He also drew the attention of Mr. East, representing the Electricity Commissioners, to the Borough Electrical Engineer's report that the cement dust nuisance had seriously affected the work of his meter testing department and asked for the assistance of the Technical Committee in investigating their complaints.

Councillor G. Anderson (Lanark) mentioned the difficulties of getting industrialists to attempt curtailment of fumes because of the extra expenditure involved and he felt that a larger part of the Conference discussions should be developed with a view to ascertaining the best possible method of approaching the problem.

R. E. Gamlen (Yorkshire Electric Power Co.) said the question of the emission of smoke and grit from Power Station Chimneys which had received so much attention during the morning, might be looked at from another angle. One power station of, say, 60,000 kw. burning fuel in the most efficient way, could eliminate, say, 30,000 domestic coal burning domestic fires and cookers, 300 works chimneys representing installations of 200 h.p. each, or could supply a large proportion of the heat, lighting and power requirements of an average town of, say, 100,000 population. If the public supply of electricity were not now being used extensively in our many factories and collieries (whose combustion efficiency was generally lower than in the case of power stations) the deposit of grit and the products of combustion would be very much greater than at present experienced.

The electricity supply industry was suffering from difficulties in respect of the variety of fuel delivered and would like to obtain washed coal of a standard size which would enable the general efficiency to be still further improved. The industry were aware of the importance of the problem, and as shown by Mr. East, high standards were set for all power stations to attain.

In a later note, Mr. Gamlen said that in his reply, Mr. James Law had stated that the Society was against all smoke however produced, and if it came from one chimney or many, it was just as bad. This evaded his point which was that the public supply of electricity helped to abate very substantially the total amount of smoke produced in that combustion at power stations was more efficiently carried out than in the majority of domestic houses and small works.

G. W. Farquharson (Birmingham) commenting upon the joint paper by Mr. Law and himself, said that he would like to stress the point that the Technical Committee of the Society is at their service, and was at all times willing to give advice and practical help as far as it is in their power to any member of the Society. They had heard at a previous session of the Chain Grate Stoker as applied to the Lancashire boiler and undoubtedly that class of stoker burned a low grade fuel efficiently and without grit emissions. The cost of £650 per stoker could be considered comparatively high, but with low maintenance cost and utilization of such fuel as colliery fines, etc., this type of stoker would appear to

be an ideal method to be adapted on the Lancashire boilers usually found at collieries. Perhaps the National Coal Board would interest themselves in this method of disposal of certain colliery waste.

In regard to Electricity Power Stations, he would like to draw their attention to the official figures contained in their joint effort, and especially to the equivalent of sulphur eliminated by flue gas washing at the stations mentioned. These figures alone were quite sufficient to strengthen the argument that all future stations should be provided with some means of sulphur dioxide elimination.

Mr. Farquharson, replying to Mr. Smith of the Combustion Appliance Makers' Association, said that his remarks on the Chain Grate Stoker and its efficient method of burning low grade fuel, did not by any means infer that there were no other stokers or mechanical appliances which did not do similar work. He only mentioned it because as applied to Lancashire boilers it was comparatively new.

James Law replying to the discussion said that there were a number of questions which were going to be difficult to reply to, but he would do his best to give satisfactory answers.

Replying to Mr. Swift, he said that little could be done to abate a grit and sulphur nuisance from an electrical power station that had not been designed for flue gas cleaning. Attempts had been made to fit electrostatic precipitators to existing boilers and in the case of other stations to erect a tall chimney in the hope that the grit and sulphur would be dissipated over a large area. These efforts had to be regarded as palliatives rather than cures. With regard to a laundry boiler using inferior fuel, it was much simpler to change the fuel than to fit a grit arrestor, and application should be made to the Ministry of Fuel for a better grade for this purpose.

Replying to Mr. East who spoke for the Electricity Commissioners, he said it was not honest or fair to state that the nuisances complained of were of a trivial nature, and it was an insult to the intelligence of the delegates to make statements of that kind. Mr. Law said he worked in the Don Valley and was responsible to the people of that valley for the state of the atmosphere. There were four power stations burning almost a million and a quarter tons of fuel per annum, and if the average sulphur content was 1.5 per cent. of that tota the sulphur dioxide emitted averaged over 107 tons per day. These figures had been given by the Power Station Engineers and must be accepted. Where did this sulphur go to? It was cooled and deposited on the inhabitants in the vicinity of the power stations. Added to this, schemes of reconstruction were contemplated which would double the consumption of fuel within the next five years and no guarantee or promise had been given that any apparatus would be installed to clean the flue gases when these additions were put into operation. The position of people living in the valley was likely to become intolerable unless some provisions were made for reducing the grit and sulphur from these chimneys. That was why the resolution which was carried at a conference last year had been repeated and immediate action was necessary if any improvement was to take place.

Replying to Mr. Marsden, of Corby, he said if there was to be any future change of conditions it would be necessary to press forward with the new byelaws so that "prior approval" could be obtained for the erection of any new blast furnaces which would be erected.

Mr. Law noticed that Mr. Roberts took strong exception to the expression "that gasworks and coke ovens are an abomination." If he looked at the wording of the paper he would have noticed that the statement said that they "can be an abomination" and there was no doubt that some of the older types did come under that category. If Mr. Roberts had any doubt about the matter Mr. Law would have been only too pleased to show him when he was next in the vicinity of Sheffield.

He expressed appreciation to Mr. Ashford, of Glasgow, for his support with regard to the difficulty of dealing with grit and sulphur emission from small factories.

He said that Mr. Gamlen's figures with regard to pollution from electricity power stations were very interesting, but he would point out to him that we were not defending nuisance caused by houses or small boiler plants and that it was quite unfair to make comparisons in that manner. Two "blacks" could not make a "white" and electricity power stations should and could be definitely free from fumes or grit. To state that a large power station was the equivalent of a thousand houses or a hundred small boilers did not in any

way excuse pollution.

Arnold Marsh replying, said he wished only to refer to Mr. East's statement that the 15 generating stations mentioned in the opening survey represented only about 4 per cent. of the 350 public generating stations in the country, and that this was scarcely sufficient reason to call for universal gas-washing. The point was, however, that the cases analysed in the survey were merely a sample set that had happened to come to the notice of the Society. It was not necessarily a representative sample, but in any case it was highly significant that of such random cases about one-half related to generating stations. The sample could give no indication of the total number of cases of this or any other type, but as far as proportions went, the generating stations started off with a remarkable lead over the rest of the field.

The Price of Smoke

Introductory Remarks by the Chairman

The Rt. Hon. LORD SEMPILL, A.F.C., F.R.Aë., F.I.P.E.

I HAVE been interested in smoke abatement and the Society for many years—ever since, in fact, the smoke palls overhanging our towns and cities had become so apparent to me in the early days of flying. On one occasion in Cornwall, my aeroplane was left overnight in the open. There was a north-east wind and during the night there was a slight rain. In the morning the plane was covered with soot—which must have been carried from the Midlands industrial area.

I am pleased to welcome the first of the two speakers, Sir Alexander Macgregor. He belongs to a clan for which I have the greatest respect. Times have changed for the better, for if we had met in past ages, I might have greeted Sir Alexander by chasing him down the Royal Mile !

A3

Smoke and the Public Health

By SIR ALEXANDER MACGREGOR, O.B.E., M.D., LL.D., F.R.F.P.S.G.,
formerly Medical Officer of Health, Glasgow.

THE National Smoke Abatement Society and its active member authorities have already rendered conspicuous service to the public health. There is evidence that, during the past quarter of a century, the production of smoke has lessened and its ill-effects on health have diminished. The Barlow Report on the Distribution of the Industrial Population (1940) contains a number of references to the relation between smoke and health, from which the following are quoted. "Taking the country as a whole, smoke pollution of the atmosphere is undoubtedly decreasing . . . Nevertheless, it is true that smoke pollution still persists to a harmful extent in many large towns"; again, "The adverse effects of smoke upon health were emphasized in evidence by the Registrar-General for England and Wales"; also, "Statistics submitted to the Commission appear not only to establish a correlation between smoke pollution of the atmosphere and health and the excess mortality of the northern towns, but to show that though the harmful effects of the smoke-producing heavy or textile industries upon health have diminished during the last 21 years, those effects are still very potent."

Further progress towards a cleaner atmosphere may be anticipated as the result of the increasing application of fuel efficiency methods in industry and in housing. But the objects of the Society will find their strongest support in the present-day ideals of health and amenity that are rapidly gaining ground, because these ideals are inconsistent with continued pollution of the air. The measures now coming into force relating to the health of the people and the planning of towns, which reflect the spirit of the times, hold out the promise of the highest attainable standard of health for all and the prospect of life in the "noble cities" envisaged by Mr. Noel Baker in a romantic moment. A sombre and unhealthy life in the midst of smoke is incompatible with the aims of a positive health policy, aims which will not be completely realized unless the smoke problem can be finally solved.

The volume of smoke produced in different areas and the factors which influence it have been studied and publicized over many years by the Society. It is true to say that national and local efforts, in which many manufacturers have co-operated, have effected considerable change for the better. But the figures for air pollution are still formidable. In Glasgow, in 1938, there was a mean monthly precipitation of 19.3 tons per square mile, or 232 tons for the year, which compares with a precipitation of about 5 tons at Loch Katrine, 30 miles to the north. This figure for Glasgow is half of what it was thirty years ago. In some towns in England, higher figures are recorded; in one town 500 tons, in another 1,000 tons, and in a localized district as much as 5,000 tons per annum. Dr. A. Parker*, Director of Fuel Research in the Department of Fuel and Industrial Research, has recently estimated, for the whole country, the weight of tarry and carbonaceous matter at between 2 and 2½ million tons a year, the oxides of sulphur at about 5 million tons, and the grit and ash at roughly 0.5 million tons.

A great many observations have been made both in this country and in America on these impurities as direct causes of a variety of diseases in smoky towns; some of them are not very convincing. The effect of these impurities in the air depends on their degree of concentration. That they may act as a definite irritant to the respiratory tract is well recognized, a harmful effect that has again been pointed out in a resolution by the specialists in diseases of the lungs and in diseases of children of St. Louis, which is, or was, one of the smokiest towns in the United States.

* Smokeless Air No. 58, 1945.

In public health matters, it is often difficult to assess in precise terms the relation between cause and effect. For one thing, man's body has considerable powers of adapting itself to its environment. In the case of smoke impurities, we may surmise that this process has been going on for the past 140 years, just as we have adapted our minds to the gloom ushered in by the industrial era. Of this earlier period, which G. M. Trevelyan describes as being "marked by the growth of great cities under their pall of soot and fog," he says that "the divorce from nature was absolute."

People who live and work under a smoke screen are affected in two main ways; (a) They suffer, under certain circumstances, the direct ill-effects of breathing smoke-laden air and its chemical impurities, and (b) the effective sunshine is reduced, and they are deprived to this extent of a full measure of health. Among other consequences, we may note in passing, the wasted energy which the housewife has to expend on the frequent washing of clothes and the cleaning of houses in and around a smoky town.

Smoke and Fog

The first serious charge that can be brought against smoke pollution is that, under certain atmospheric conditions, it assists literally in the destruction of life itself. The deleterious effects of smoke can be seen at their worst when fog and frost together overtake a smoky town in the winter months, permitting a high concentration of grit, tar and sulphur to play upon the inhabitants. The effect of this combination is to send up the incidence and mortality from pneumonia and bronchitis during the occurrence and for weeks thereafter. Numerous instances of this have been recorded. Although cold weather smoke-fogs have become less dense and less disastrous than they used to be in the days of really black smoke and the pea-soup variety of fog, nevertheless fogs of varying density and duration are still common. A considerable literature has grown round this well-known phenomenon, and I need only mention one or two examples.

One of the worst examples was a fog of 74 hours' duration in Glasgow in January, 1929, accompanied by frost and influenza, when the death rate rose to the high figure of 50.3 in the third week of the month as compared with 15.3 per thousand population for the whole year. In 1928, Manchester had thirteen days of fog during February, the death rate rising to 34.4 by the end of the month, as compared with the annual rate of 13.2 per thousand. In 1940, Professor J. Johnstone Jervis reported, in a paper to the Society, that Leeds had experienced "one of the blackest fogs it had had for a long time"; the effect of it was to "send the death rate soaring to a high level." He was not quite sure how much blame to lay on the fog itself, or on the low temperature which accompanied it.

Professor Jervis permits me to quote from his valuable records of this experience at Leeds. In the first quarter of 1940, the deaths from respiratory diseases were double the average number during the first quarter of any year in the decennium 1935-45. The beginning of this high prevalence, in the weeks ending January 13th (48 deaths) and 20th (76 deaths), coincided with and followed a period of frost and dense fog lasting for six days. At Harrogate and Ilkley, twenty miles distant from Leeds and from one another, the temperature ranges were generally lower than at Leeds, but throughout the period the deaths were very few. Comparing fog days, Leeds had thirteen during the first quarter, Harrogate fourteen, and Ilkley nine, so that Harrogate had more "fog" than Leeds and lower temperatures. But the "fog" at Harrogate and Ilkley would not be charged with smoke. Taking Harrogate as 100, Leeds received 50 per cent. and Ilkley 80 per cent. of the recorded sunshine. The difference of death rates, therefore, must be due to the smoke pollution with low temperature and not just "mist" and low temperature. This tends to show that "mist" is not highly detrimental to health in respect of respiratory diseases unless smoke pollution is also present.

The amount of sickness that smoke fogs can cause is, of course, much greater than can be measured by crude vital statistics. The irritant effect on the mucous membrane of the respiratory tract is specially felt by elderly people with a tendency to bronchial catarrh. They are the first to take ill when a smoke fog arrives. Although the density of fogs has definitely lessened during the past twenty or thirty years, they still occur, while scarcely a winter passes without some foggy days. For instance, during 1941, in Glasgow, there were 8 foggy days in November and 13 in December; in 1942, there were 21 in

January, 15 in February, and 10 in March. During the past severe winter there was no smoke fog of any consequence, but the public had a good ocular demonstration of the reality of the smoke nuisance when the snow, which lay for a considerable time, was covered by an ever-growing carpet of soot and grit even in the outer suburbs, which transformed its glistening white surface into an object of disgust.

Our Glasgow experience is that keen frost, fog and still air occurring together form a sinster combination. An opportunity occurred some years ago to compare a period of low temperature with fog and a period of low temperature without fog, the mean temperature of 30.7 deg. F. being the same in both periods. In the first period, during November, 1909, with five days of dense fog and frost, the general death rate rose from 13 to 33 per thousand, respiratory diseases accounting for 49 per cent. or approximately half the total deaths, equivalent to a death rate of 14 per thousand population. On the other hand, in the second period, during February, 1912, with frost but without fog, the general death rate was 26.6, respiratory diseases forming 28 per cent, or just over a quarter of the total, equivalent to a death rate of 6.4 per thousand population. Dr. A. K. Chalmers, in his Annual Report for 1912, said of this experience, that it exhibited "the asphyxiating effect of fog when associated with continued low temperature, disastrous alike at both extremes of life."

The effect of smoke on health was fully discussed by the Registrar-General for England and Wales in the minutes of evidence taken before the Royal Commission on the Geographical Distribution of the Industrial Population. Smoke was held to account for some part at least of the higher mortality rates of children under five years from pneumonia and bronchitis in the Midland industrial area of the country as compared with other more southerly areas, after taking into account the distribution of the populations according to density per acre and per room, this difference being "chiefly attributable to smoke with its attendant fog and deprivation of sunshine."

With regard to sunshine, the Registrar-General points out that "the lowest averages for 1930-32 were given by Bolton (975 hours), Manchester (983 hours) and Burnley (1,009 hours), which when compared with Blackpool (1,368 hours) in the same zone of latitude, indicate how serious this deprivation of sunlight may be."

The particular attribute of smoke which a medical officer of health views with most concern, is its power to absorb light. This applies, in especial degree, to the health-giving ultra-violet rays from the sun and sky which possess poor penetrating power and are readily filtered off by the smoke and dust of towns. It is estimated that this loss of ultra-violet radiation may amount to from 50 to 80 per cent., or may even be total, according to the degree of smoke concentration in the air.

These are the rays from which mankind derives the greatest benefit, especially the growing child. The tanned appearance of the countryman shows that he gets more of them than does the townsman; in our holidays we go in search of them. This is one of the reasons why we place our sanatoria and convalescent homes and, above all, our institutions for children as much in the country as possible, or, at any rate, in the least smoky suburban areas. The rays from ultra-violet lamps are often employed in medical practice for their tonic and invigorating effect and for the treatment of rickets and other affections. They are sometimes used in industry to promote the health of the workers in mines and factories. The property they possess of destroying bacteria in the air is taken advantage of in certain processes and in hospitals where, for special reasons, it is desirable to make use of a germicidal agent.

The amount of daylight and of ultra-violet radiation reaching the ground can be roughly measured. Mr. A. R. Jamieson, the Glasgow City Analyst, has provided me with his figures for 1939-40 referable to two stations, one at Mearnskirk Hospital seven miles to the south-west, the other in the centre of the city at Glasgow Cross. The measurements follow on next page.

These figures show the great difference that exists between those town and country stations in summer as well as in winter. For instance, in summer, the city centre received 36 per cent. of the daylight and 41 per cent. of the ultra-violet radiation recorded at Mearnskirk Hospital seven miles away. In winter, the figures were 42 and 55 per cent. respectively. Similarly, in Manchester

over an eight-year period, the city centre obtained 68.6 per cent. of the daylight received at a station in Cheshire seven miles to the south-west. Other areas of the city received 39.1 and 52.6 per cent. respectively, these being stations which lie in the direction to which smoke is carried by prevailing winds from the area containing heavy industry and high density housing. I am indebted to Dr. Metcalfe Brown for this information. Thus, taking these country measurements as standards, the comparative figures reveal the big loss of health-giving solar radiation which the adjacent city sustains, mainly owing to the smoke which overhangs it.

	Daylight Measurement Iodine (in mgms.)		*Ultra-Violet Radiation Methylene Blue (in Units)*	
	Glasgow Cross	*Mearns-kirk*	*Glasgow Cross*	*Mearns-kirk*
Summer Months (Average)	131.7	366.91	7.4	17.83
Winter Months (Average)	51.39	142.3	2.25	4.08

The Importance of Vitamin D

In order to understand the significance for health of this deprivation, it is necessary to explain that, in terms of bio-chemistry, ultra-violet radiation effects a synthesis of Vitamin D in the body, a vitamin which is essential for bodily health, especially the healthy growth of the tissues. Enough is known about this substance to reveal its special value for the growing child and the expectant mother. For instance, lack of it is regarded as a direct cause of rickets, which is classified among the "deficiency" diseases. Accordingly, it is of great importance that young children should obtain as much of this vitamin as they need for healthy development and good nourishment, especially as comparatively few foods are good sources of it. This applies particularly to artificially fed infants, and it is for this reason that the administration of ready-made Vitamin D in cod liver oil is so strongly recommended by doctors and by child welfare departments, especially in the towns, as a preventive measure.

Without wishing to over-elaborate, I think it relevant to mention an experience we had in Glasgow during the war, when the Ministry of Food reinforced its national dried milk with Vitamin D (the amount added being equivalent to 800 imperial units for each pint of reconstituted milk). During 1944 and 1945, as the result of intensive propaganda, this milk rapidly became the principal infant food of the industrial areas of the city. The Chief Child Welfare Officer, Dr. N. I. Wattie, reporting on child life and the progressive decline of rickets over the past years, says, "During 1945, however, there was a further striking fall in the incidence; it is a fair assumption that this change in the feeding of such a large proportion of Glasgow children is the chief reason for the reduction in the incidence of rickets and a factor in the reduction of the infant mortality rate, a biological experiment of profound significance." This was a big change from the traditional use of liquid milk in infant feeding. I may add that, at the time when Vitamin D was to be added to the dried milk, we had suggested the amount mentioned above, because of the data I have quoted in relation to the loss of ultra-violet radiation due to smoke sustained by the northern industrial belt of which the city is a part.

On this question of child life in a big city, the improvement in mortality, sickness and general physical condition has been an outstanding feature of quite recent times. For this result, a number of factors have been responsible, each contributing its own influence in varying degree. Apart from better mothercraft, better nutrition and improved housing conditions for many people, on which most emphasis must be placed, there is little doubt in my mind that a prominent factor has been the reduced production of smoke since the smoke abatement service of the Health Department was introduced and carried on by a very competent staff.

A recent publication by the Department of Scientific and Industrial Research (Atmospheric Pollution Research)* says that "in the towns and cities of the

* Atmospheric Pollution in Leicester: A Scientific Survey. H.M.S.O., 1945.

British Isles there are many people whose state of health would be improved by additional sunlight." I have stressed this interference with the natural sources of health, because I am convinced that, apart from the directly deleterious effects of air pollution, it is an important factor in the state of health of towns.

I have discussed the direct effect of smoke on the respiratory diseases and the indirect effect on health which it exerts by reducing the effective sunshine, in particular the ultra-violet rays from the sun and sky. In this climate, a full measure of sunshine cannot be relied upon, especially in the winter months, but even in summer the amount of ultra-violet radiation is much diminished by a curtain of smoke. The benefit to health which young life in particular should obtain from natural sources is lost through the agency of smoke and has to be made good by pharmacy. It is clear that a smoke screen interposes a barrier between the inhabitants of a town and the enjoyment of a fuller measure of health.

Atmospheric Pollution in Great Britain

in relation to the burning of Coal

A21

By C. E. P. BROOKS, D.Sc.,
of the Meteorological Office

THE amount of smoke and dust in the atmosphere is a matter of general interest because of its effect on the life of the whole community. Unfortunately the distribution over this country of impurity actually suspended in the atmosphere is not well-known, especially in the country districts where it is small. In studying the geographical distribution of pollution over Britain, therefore, it was necessary to use instead, the much simplier and more widely distributed measures of the total deposited matter collected in pollution gauges. Since a large proportion of this consists of relatively heavy particles which are deposited near their sources, while the suspended impurity consists mainly of finer particles which are carried further afield, the result is probably to paint the towns blacker and the neighbouring countryside less black than is really the case.

For many years measurements of atmospheric pollution have been made by means of pollution gauges at a constantly growing number of stations in Great Britain, and published in the Annual Reports of the Advisory Committee on Atmospheric Pollution, issued by the Meteorological Office from 1915 until 1926, and subsequently by the Department of Scientific and Industrial Research. When these data had been extracted, it was found that the figures were high near the centres of large towns, and usually decreased rapidly to the west and south-west, more slowly to the east and north-east. In each district there is a general level of pollution, which varies from one part of the country to another, and superposed on this, are a number of sources of local pollution represented by the large towns. It seemed desirable to discuss these two elements, " country " and " town " pollution, separately.

To represent country pollution, those places were selected which are either in open-country well away from large towns nor industrial centres, or lie some miles to the west or south-west of the nearest source of pollution. These figures were plotted and lines of equal " country " pollution were drawn over most of England and Southern Scotland (fig. 1). There is unfortunately a complete lack of information for Wales, south-west England, Sussex, Kent and East Anglia. This map shows, as would be expected, that the air is cleanest in the west and south. The station with the smallest average deposit is Loggerheads, which lies 12 miles to the south-west of Stoke-on-Trent, with open-country to the west. Here the mean annual deposit over two years was 23 metric tons per square km., and this figure rises to about 55 tons near the three great smoke-producing centres of central Scotland, the manufacturing districts of Lancashire and Yorkshire, and the London area.

The effect of large towns on the amount of deposited pollution is very local.

In a few cases, sufficient gauges have been in operation to enable maps to be drawn with a fair degree of confidence, and these show the combined effects of the prevailing winds and topography. Thus the industrial belt of central Scotland (fig. 2) shows a high concentration of smoke along the Clyde Valley, especially to the east, a rapid decrease to the south and south-west and a slower decrease to the north. Six miles to the south the average has fallen to 37 metric tons, while some 30 miles to the north, in open country, it is still as high as 43 to 55 tons.

Manchester and Salford (fig. 3) show

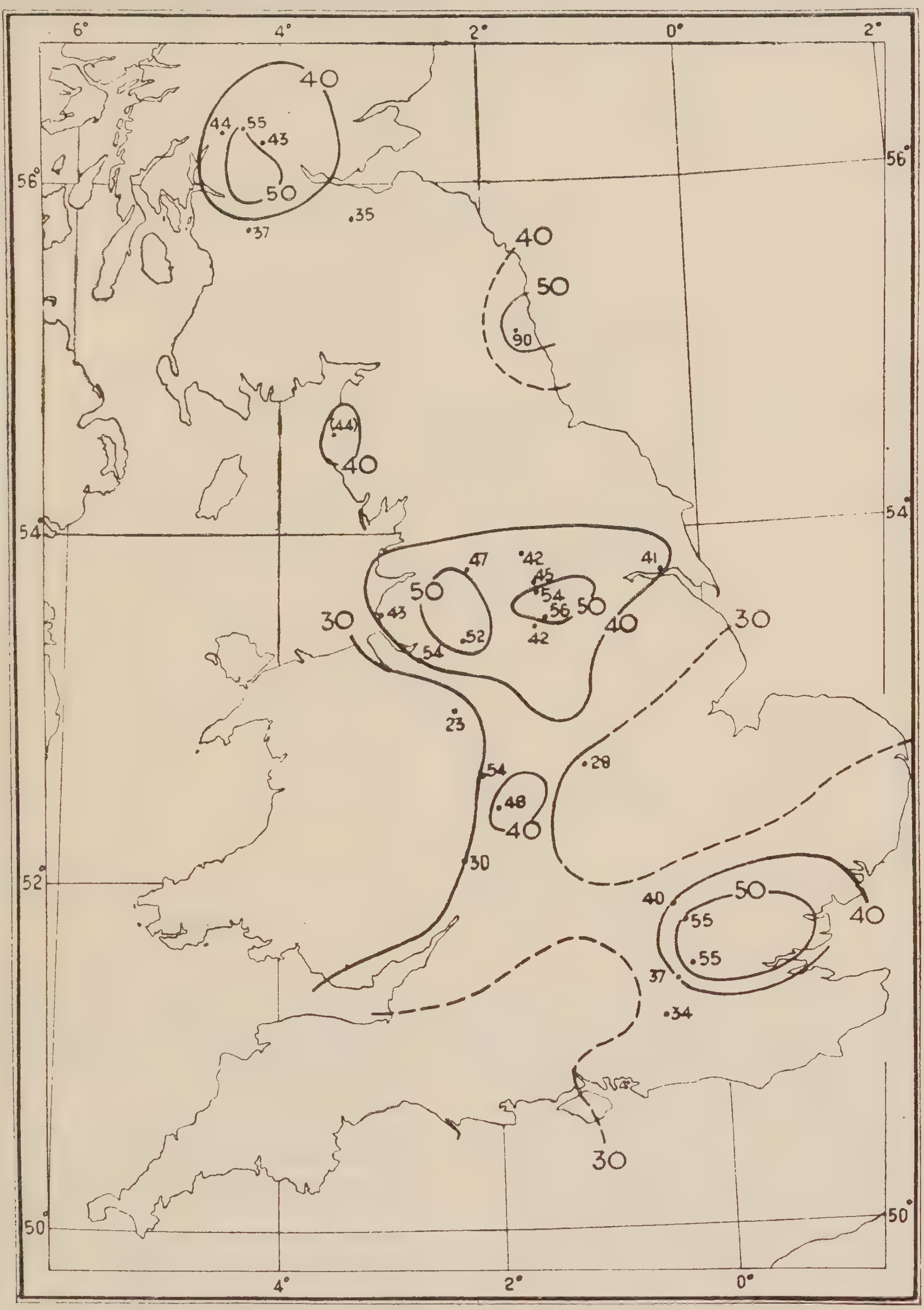

Fig. 1. Sketch map to show distribution of total solid deposits (metric tons per sq. km.) per annum, over open country and to windward of main centres of pollution.

a much more complex distribution owing to the presence of smaller manufacturing areas on all sides except the east. There is an area of clean air to the south, and also indication of a rapid decrease of pollution eastwards. The latter feature, if correct, is probably caused by eddies on the windward side of the Pennines.

By combining in one map all towns (except London) which had one station at the centre and others at different distances from it, and expressing pollution at the latter as percentages of that at the centre, it was possible to construct a generalized picture of smoke pollution in a British town (fig. 4). This shows that though the maximum deposit is displaced eastwards by less than half-a-mile, the whole area of heavy pollution is elongated towards the east.

This conclusion can be compared with the results of detailed investigations of smoke pollution around Leicester, obtained by the use of smoke filters instead of deposit gauges, described in Atmospheric Pollution Research Technical Paper No. 1 of the Department of Scientific and Industrial Research, published by H.M.S.O. in 1945. These give a measure of the suspended impurity as compared with the deposited impurity recorded by deposit gauges. Similar measurements were also made of sulphur dioxide. The greatest concentration of smoke and sulphur dioxide is invariably to be found at the centre of Leicester, but in the outer suburbs there is much more suspended pollution on days when the wind blows from the centre of the city than on other days.

As a means of comparing the amount and distribution of deposited pollution with the consumption of coal, figures of the latter were kindly provided by the Ministry of Fuel and Power. These included a specimen week of industrial supplies and specimen year of domestic supplies; they were sorted out and plotted on large-scale maps divided into 10 km. squares by Dr. Willatts at the Ministry of Town and Country Planning

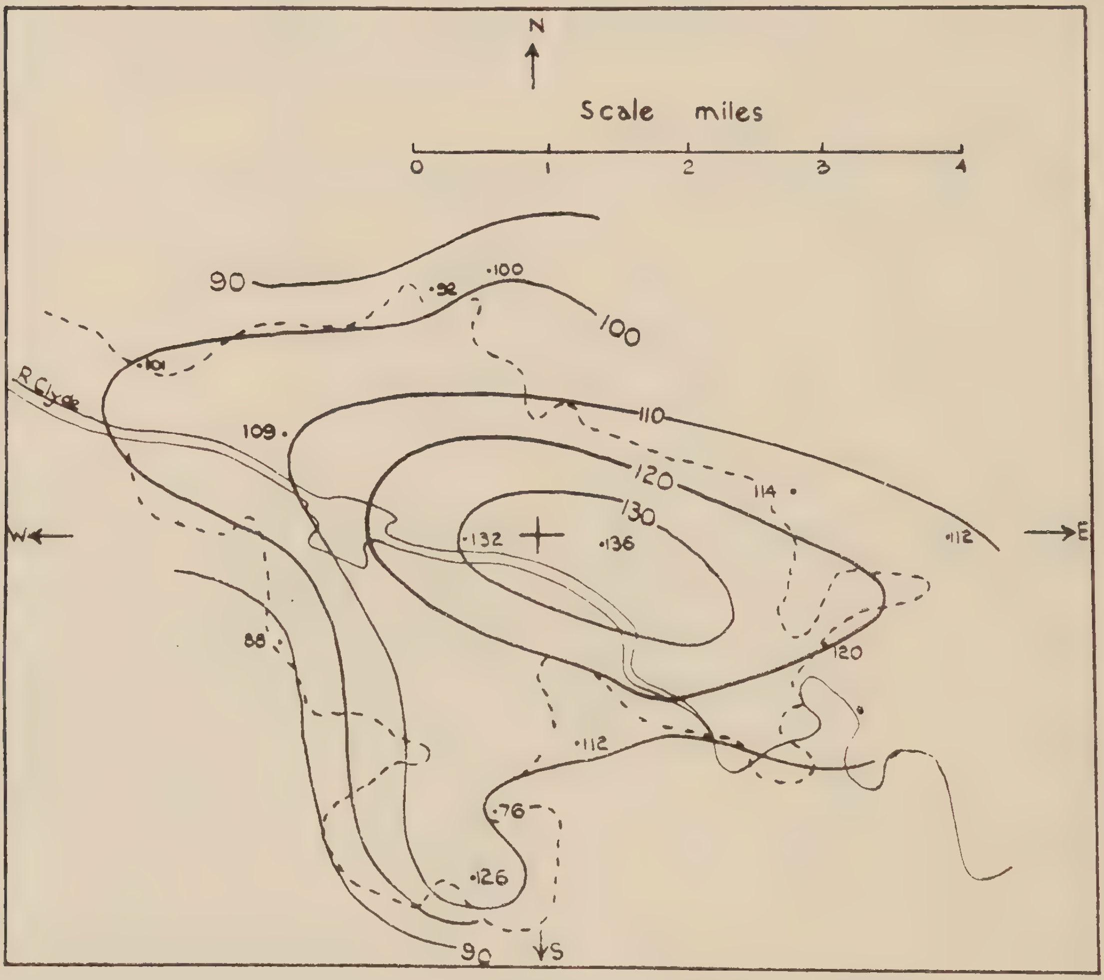

Fig. 2. Glasgow. Solid deposits in metric tons per sq. km.

Some data published by Dr. A. Parker showed that domestic consumption produces on the average about twice as much smoke per ton of coal as industrial consumption. The industrial consumption in each 10 km. square was accordingly halved and added to the domestic consumption, the resulting figure being the number of tons of "pollution-consumption" per square km. This map bears a fairly close resemblance to fig. 1, the centres of pollution at Glasgow, Newcastle, Manchester, Leeds, Birmingham and London all standing out on both charts, but the observed deposits all show some displacement towards the

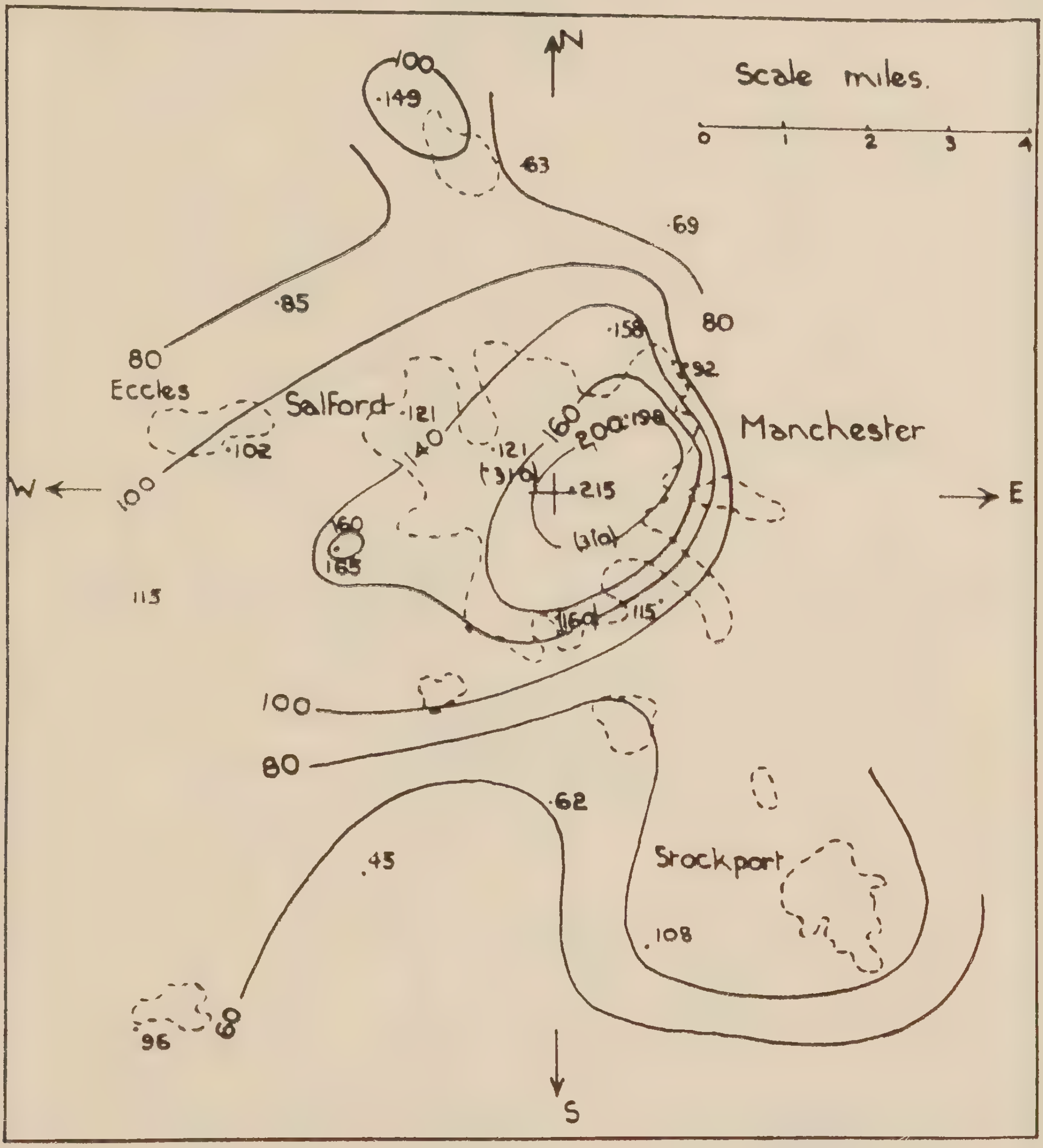

Fig. 3. Manchester and Salford. Solid deposits in metric tons per sq. km.

termed the "pollution-consumption." These figures were plotted on a smaller scale map, but they were rather irregular, depending on the distribution of townships of moderate size. To obtain a more generalized map of the sources of pollution, the figures were smoothed by replacing that for each 10 km. square by the mean of nine squares of which it is the centre. Fig. 5 is a map based on these generalized values, which represents east and north-east due to the prevailing winds.

The consumption of coal is not the only source of the atmospheric pollution which finds its way into the deposit gauge; vegetation, refuse, wear of roads and buildings, peat and wood fires and other factors each contribute their quota. It is interesting to estimate the contribution of these additional sources to the total deposit.

There is no pollution gauge in England in such a position that we can regard the deposit as derived entirely from sources other than the consumption of coal. The nearest approach is Loggerheads, but even here easterly winds, which blow for 11 per cent. of the time (excluding light airs), must bring an appreciable amount of pollution. From a comparison of the deposits at seven country places with the duration of winds blowing from sources of pollution, it was estimated that the amount which would be recorded by a gauge far removed from all consumption of coal would be about 17 tons per square. km. a year. We may call this figure the "country pollution."

There is no direct means of estimating the quantity of deposits in towns resulting from other sources than the burning of coal. In towns there is less bare soil than in the country, but on the other hand there is more wear of roads and buildings and more household dust. We may regard the figure of 17 tons so

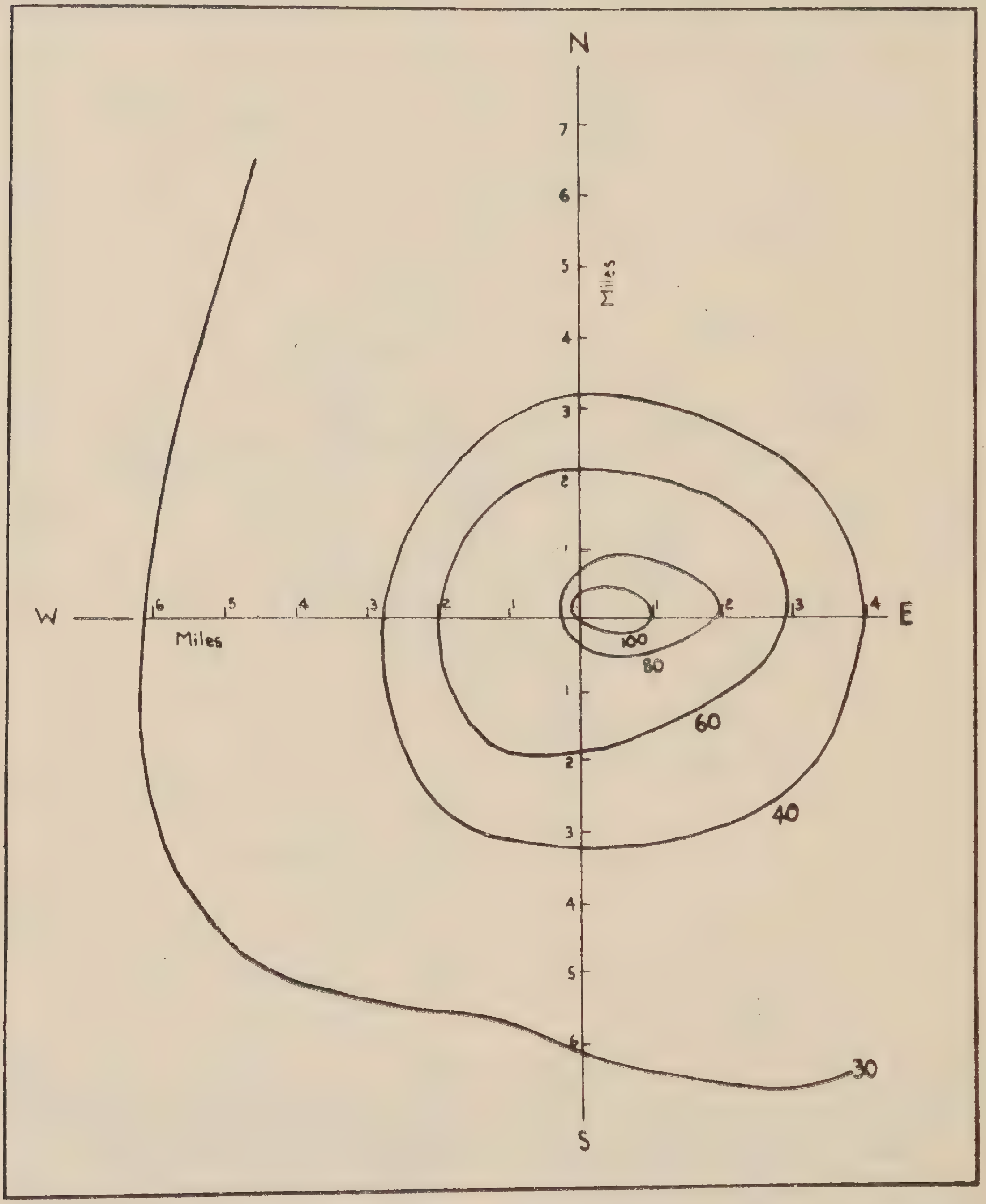

Fig. 4. Composite map of pollution expressed as a percentage of that at the centre of a town.

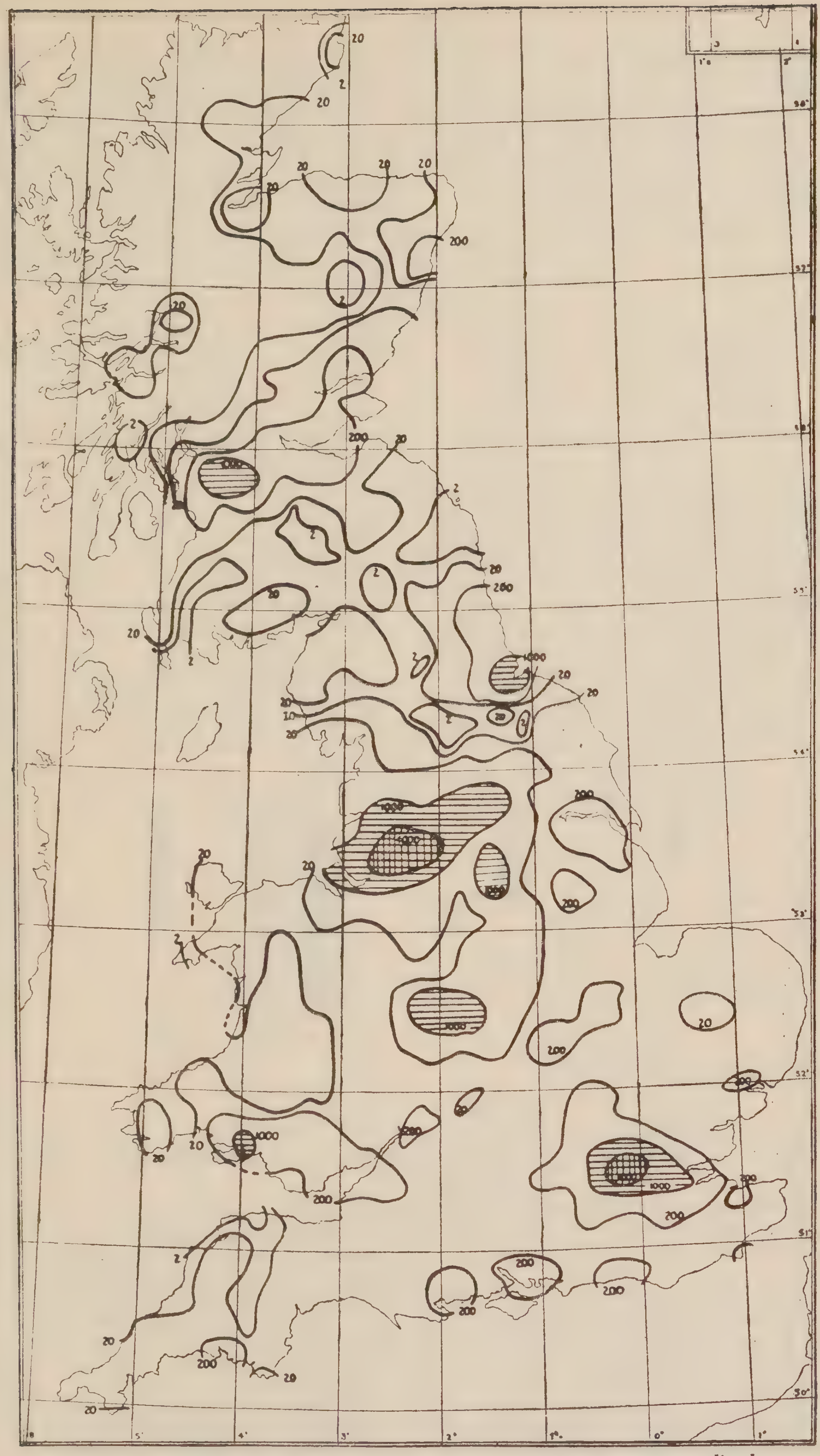

Fig: 5. "Pollution-consumption" in tons per sq. Km. per year, generalized.

roughly applicable to town as well as country.

We can now make an estimate of the amount of solid deposits over England, and the amount resulting from the burning of coal. The calculation is shown in the following table :

	Area Sq. km.	*Solid deposits tons per sq. km.*	*Total deposits tons*	*Deposition from coal consumption tons*
London... ...	1,100	101	111,100	92,400
91 other towns...	3,860	78	301,080	235,460
Country ...	123,900	33	4,088,700	1,982,400
Total	126,860	35	4,500,800	2,310,260

Taking London as an example, the built-up area measured on a large-scale map is 1,100 sq. km. The average solid deposit at 18 stations in London is 101 tons per sq. km., giving the total deposit as 11,100 tons. Allowing 17 tons per sq. km., for "country" pollution, we find that the latter amounts to 18,700 tons over the whole area. The remainder, 92,400 tons, is due to the consumption of coal. Similarly, the areas of 91 other towns were measured and the average deposit found for those for which figures were available. The average solid deposit over the country away from towns was estimated from fig. 1.

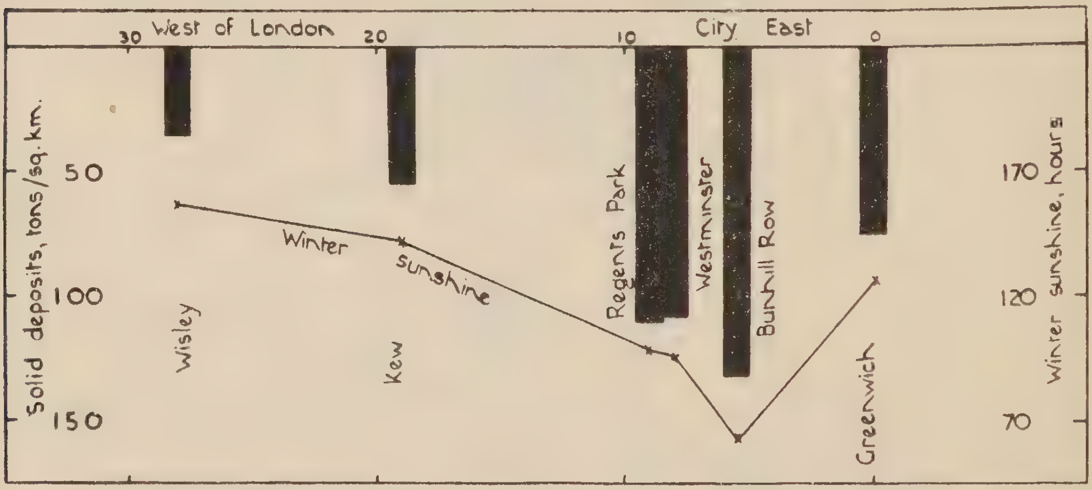

Fig. 6. Section across London, West-East, to show how pollution affects winter sunshine.

This table shows that in the larger towns the burning of coal is responsible for by far the greater part of the deposited impurity, more than 80 per cent. in London and nearly 80 per cent. in other large towns. On the other hand, even in the country away from large towns it is estimated that practically half the deposited impurity springs from coal consumption. Most of this is probably carried from the towns, but some of it is no doubt due to minor local sources of pollution ; in fact, the presence of a deposit gauge itself implies local habitation. Over England as a whole it seems probable that a little more than half the total deposit results from the burning of coal and the remainder from other sources. It is not practicable to make similar calculations for Wales and Scotland, but in those countries it is to be expected that "country pollution" exercised the dominant effect. The area of the country is so large compared with the combined areas of the towns that this result implies that the larger part of the products of combustion of coal in towns is not deposited within the towns themselves, but is carried by the winds into the open country ; some of it no doubt escapes to sea. The deposits in town naturally includes a larger proportion of heavy carbonaceous and mineral particles, and a smaller proportion of such constituents as sulphur (in the form of sulphates in solution) that that in the country.

The effects of this smoke pollution on the life of the country is felt in many directions. It cuts down the hours of

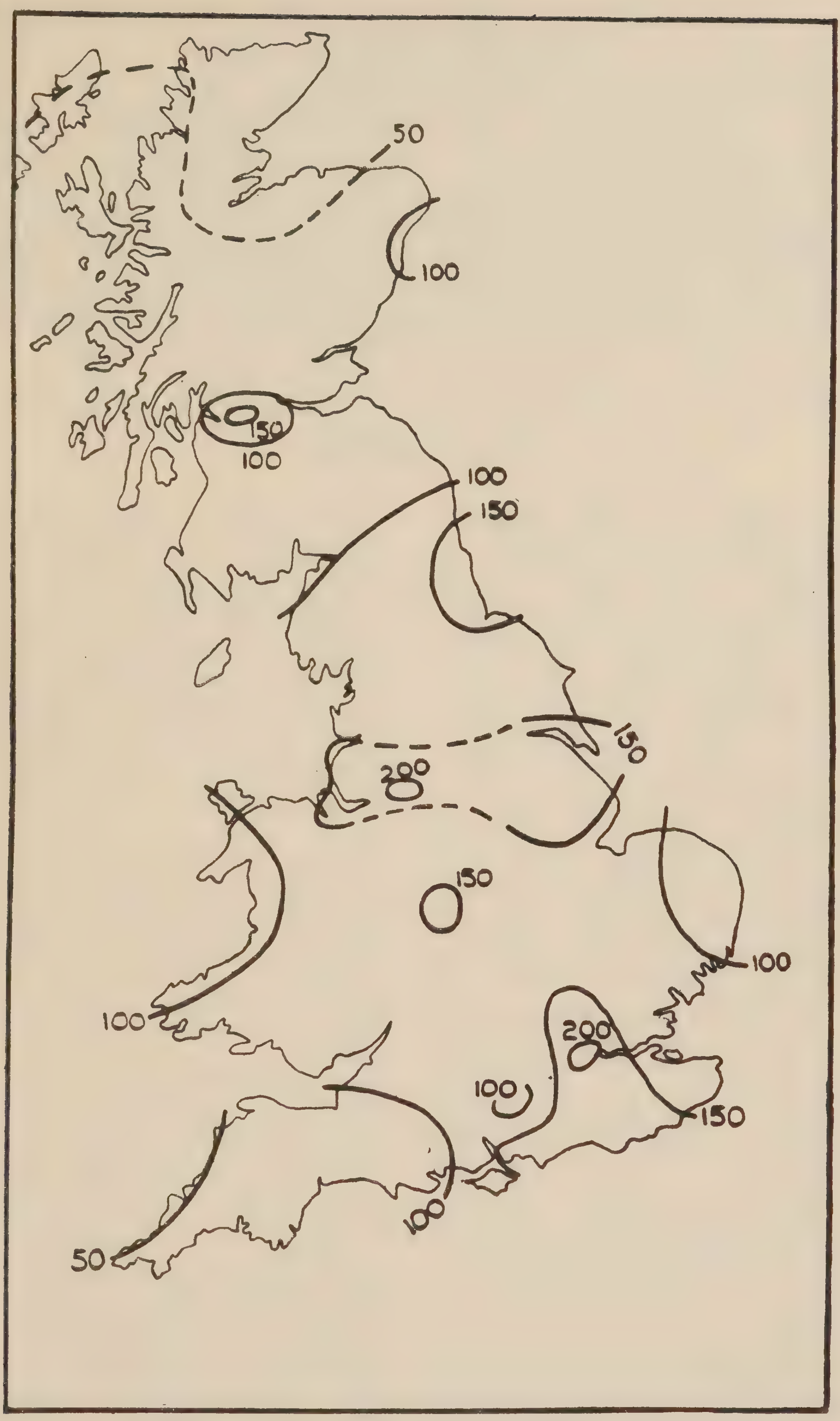

Fig. 7. Frequency of visibility less than 6¼ miles at 13h. Days per year.

bright sunshine especially in winter when sunshine is most precious. Figure 6 is a cross-section of London, which shows that London's coal consumption cuts down the sunshine by about 100 hours in the three winter months. In the year as a whole, the loss is 300 hours. Even when the sun is shining, its rays are enfeebled, so that the total loss of heat and light must be very large. Another effect of smoke pollution is to decrease visibility. Smoke alone rarely causes dense fog, for which water-droplets are needed, though the addition of smoke makes London fogs much more unpleasant. But where the smoke pall is thick, there is a persistent haze which limits visibility to a few miles. This is shown in fig. 7, which shows the average number of days in the year with visibility less than 6¼ miles at mid-day. The figures range from below 50 in the clearest parts of the country to above 150 in the industrial areas of Glasgow, Lancashire, Yorkshire and Birmingham, and above 200 in Manchester and London. The similarity to figures 1 and 5 is very striking, and shows that the areas of poor visibility are directly connected with the burning of coal.

Discussion

Councillor A. Carroll (Ormskirk) said he had listened attentively to the various delegates many of whom were dogmatic in their desires to obtain immediate statutory powers to enforce industry by law or threat of proceedings to re-equip their plants to eliminate smoke and grit emission. He said that not one delegate, however, had referred to the present industrial emergency, equal in every respect to war-time conditions. The cry to-day he said was for exports, and those of them around Merseyside knew what that meant. To attempt to saddle industry to-day with further costs and delays, apart from the fact that the necessary appliances and labour were not available, was both illogical and impracticable. They could not sweep away all the fireplaces in the tens of thousands of old type houses in the country.

He reminded delegates that Rome was not built in a day, and he thought that the Executive Council was pursuing its policy on the correct lines by giving advice to industrialists, and as much publicity as possible on the detrimental effects of a smoke- and grit-filled atmosphere.

Dr. J. G. Hailwood (Ormskirk) said that while the Chair was occupied by Lord Sempill, who was known as a pioneer in aviation, a thought should be given to the danger fog presents to flying.

While agreeing fully with Sir Alexander Macgregor on the heavy sickness rates due to smoke and fog, there was also a heavy mortality rate from air crashes, due to foggy landing conditions.

It was necessary to overcome this if British aviation was to compete with other countries and therefore the Ministries concerned with aviation were intending to spend large sums of money to install FIDO—the fog dispersal apparatus—on airfields throughout the country in order to disperse fog, which had largely been produced by their colleagues at the Ministry of Fuel, the National Coal Board, the Electricity Board, and perhaps in the not far distant future, the Ministry of Transport and a National Steel Board.

Surely it would be far better if these large sums of money were spent at the source instead of on improved boiler firing, filters and dust collecting devices, and gas washing plant, thereby largely preventing smoke at the source, reducing the number of foggy days which constitute such a danger to aircraft, and improving the general health of the population.

Col. W. A. Bristow (Low Temperature Carbonization, Ltd.) asked if Sir Alexander Macgregor would agree that apart from the question of smoke and its evil effects upon health by cutting off the rays of the sun, that it was always better to warm the body by radiant heat than by warming it by central heating, provided, of course, that heating by direct radiation could be carried out conveniently, efficiently and at a low cost.

Sir Alexander Macgregor, replying to Col. Bristow's question, said that he fully agreed that for ordinary domestic purposes the best method of warming the body was by radiation.

Resolutions

The following Resolutions, after discussion, were adopted by the Conference at its final session on 3rd October:

1. Grit and Sulphur Emission

THAT this Conference of the National Smoke Abatement Society views with grave concern the menace to health and amenities caused by the emission of sulphur acids and grit from power stations, blast furnaces, steel works and coke ovens, and calls on the Ministry of Fuel and Power, the National Coal Board, and the Central Electricity Board to take immediate steps to abate these nuisances.

2. National Survey of Atmospheric Pollution

THAT the Executive Council be requested to take the necessary steps to undertake a nation-wide survey of the sources and incidence of existing atmospheric pollution and that local authorities be urged to co-operate with the Society with this object in view.

Printed at *The Leagrave Press* by Gibbs, Bamforth & Co. (Luton) Ltd., Luton and London.

PUBLICATIONS—*continued from inside front cover*

Smokeless Air. The Society's quarterly journal. The only magazine in the world devoted to the problems of atmospheric pollution. Gratis to members or 2s. 6d. per annum, post free.

Science Museum Exhibition Handbook. This is not only a detailed guide to the Exhibition, but, containing a series of twelve authoritative articles on the main aspects of the problem, is a permanent and useful reference book. 80 pages, medium 8vo. 6d.

Fumifugium: or the Smoke of London Dissipated. By John Evelyn. This rare and fascinating book, first published in 1661 by command of Charles II, has been republished by the Society with an introduction by Rose Macaulay. In spite of its age this indictment of the smoke evil by the author of the famous Diaries, remains true, witty and penetrating. Illustrated with original wood engravings and a portrait of Evelyn. Paper covers, 6d. Cloth-bound, 1s. 6d.

The State of the Atmosphere. A valuable and informative paper by the late Sir Frank Baines, F.R.I.B.A. With a section on the effects of smoke upon building stone. Royal 8vo, pp. 36. 6d.

Britain's Burning Shame. This pamphlet has been described in a review as "a masterpiece of modern popular propaganda." It puts the smoke problem in its simplest terms, especially as it affects the home, and is profusely illustrated. Single copies 2d. 12s. 6d. per 100.

Conference Proceedings. Copies are available at 1s. each of the full reports, containing papers and discussion of conferences held in 1932, 1934, 1936, (2s.), 1937, 1938 and 1943.

Smoke Emission Chart. A chart of tinted diagrams of different intensities of smoke, for making observations of chimney emissions. The grades shown are pale grey, grey, black and dense black. 3d. each, 2s. 6d. per dozen.

Smoke Abatement in Greater London. Report of a conference of London and Greater London Local Authorities, 1938. Including a paper read by the late Dr. J. S. Owens on "The present position and trends of Atmospheric Pollution in Greater London." 22 pages. 6d.

February, 1945 Joint Conference. Report of the joint conference with the Institute of Fuel, London, 23rd February, 1945. 8 papers and discussions, 45,000 words, 2s. 6d.

Smoke Control. Suggestions to Local Authorities on Guidance and Control in respect to new Fuel Burning Installations. 8 pages, 3d.

The Smoke Problem and Science Teaching. A booklet for teachers with notes and experiments 8 pages, 3d.

Smokeless Zones. A booklet explaining the Society's proposals for ending the smoke nuisance by the setting up of smokeless zones. 3d.

All Post Free Reduced Prices for Quantities

NATIONAL SMOKE ABATEMENT SOCIETY

14th Annual Conference

at

EDINBURGH

Wednesday · 1st October
to
Saturday · 4th October

1947

Programme

Arrangements and General Information.

Meeting Place. All meetings, with the exception of the Reception and the Conference Dinner, will be held in the Freemasons' Hall, George Street, Edinburgh.

Other Documents. Either with this programme, or on or about 22nd September, delegates will receive a brochure on Edinburgh, Conference Badge and Advance Papers. Reception and Dinner Tickets will also be included where these are applicable.

Advance Papers. Advance copies of the papers to be read, as far as they are received in time for printing, will be posted with the other material on or about 22nd September. Any papers that cannot be forwarded in this way will be available at the Conference Bookstall. The Presidential Address will not be published in advance.

Reply Form. Kindly complete and return the enclosed Reply Form as soon as possible, and in any case not later than 5th September.

Reception. The Reception to be given at the City Chambers by the Lord Provost and Corporation will be limited to 250 delegates. Applications for invitations (for self or self and lady only) must be made on the enclosed Reply Form, and will be accepted up to the number of 250 strictly in the order in which they are received and opened. Admission to the City Chambers will be by Invitation Card only. Evening Dress will not be worn.

Conference Dinner. An informal conference dinner will be held at the North British Hotel on the Friday evening. The price of each ticket will be 12s. 6d. inclusive of gratuities but exclusive of drinks. Applications for tickets (for self or self and lady only) should be made on the Reply Form and the remittance enclosed. The accommodation available limits the number of tickets to 140, and they will be allocated strictly in order of receipt of applications. Remittances will be returned at once in cases where applications are received after all tickets have been sold. Evening Dress will not be worn.

Motor Coach Tour. Subject to sufficient bookings being made, a Motor Tour is being arranged for Saturday, 4th October. The charge will be £1 per head, inclusive of lunch and high tea. Application for tickets should be made on the enclosed Reply Form and remittances enclosed.

Conference Badge. The wearing of the Badge at meetings is requested in order to assist introductions to other delegates.

List of Delegates. A list of delegates and authorities represented will be available at the Bookstall and may be seen on request.

Discussions. Those wishing to speak in discussions are asked to send up their names to the platform during the session concerned. In view of the fact that discussions at smoke abatement conferences have invariably

to be cut short, all speakers are requested: (*a*) to condense their remarks as much as possible and to note the signals on the platform Speech Controller; and (*b*) to confine their remarks strictly to the specific aspect of the problem then being discussed.

Proceedings. The papers, discussions, and any resolutions will be subsequently published in volume form as *The Proceedings of the Edinburgh Conference*, 1947. A copy of this will be forwarded free of charge to all registered delegates, and extra copies will be available at 3s. each, post free.

Those who take part in the discussions are asked to send a condensed copy of their remarks, *in reported speech*, to the Secretary not later than 20th October. Verbatim reports of speeches will *not* be taken.

Bookstall. There will be a Bookstall of the Society's, H.M. Stationery Office, and other publications at the Freemasons' Hall.

Inquiries. Inquiries about arrangements and requests for information should be addressed to the Society's offices up to Monday, 29th September, and during the conference either at the Freemasons' Hall or the North British Hotel.

The only assistance the Society can give with regard to hotel accommodation is to supply a hotel list. Inquiries about hotels, touring, etc., in Scotland may be made to the Scottish Tourist Board, 20, York Place, Edinburgh, 1.

1948 Conference. It is hoped to make an announcement during the conference on the place and date of the 1948 Conference.

ARNOLD MARSH,
General Secretary.

National Smoke Abatement Society,
Chandos House,
Buckingham Gate,
*Westminster, S.W.*1.
Telephone: *ABBey* 1359.

Programme

WEDNESDAY, 1st OCTOBER

10.00 a.m. ***First Conference Session***

Chairman: The President, Sir George Elliston, M.C., M.A., J.P., D.L.

Opening of the Conference by the Rt. Hon. Sir John I. Falconer, LL.D., W.S., Lord Provost of Edinburgh.

10.20 a.m. **Area Organization for Smoke Prevention.**

(i) **Reports from the Society's Divisions**

Scotland, by Allan W. Ritchie, M.B.E., F.R.SAN.I., President, Scottish Division.

North-West, by H. Moore, Hon. Secretary, N.W. Division.

Yorkshire, by James Goodfellow, M.R.SAN.I., A.M.I.S.E., Hon. Secretary, Yorkshire Division.

(ii) **Report on the Regional Committees,** based on information received from the Committees.

(iii) **Opening of Discussion,** by Charles Gandy, Chairman of the Executive Council.

11.00 a.m. **Discussion**

12.30 p.m. **Adjournment**

3.30 p.m. **Presidential Address, followed by the Annual General Meeting of the Society.**

The business part of the Meeting is for Members and appointed (voting) representatives of Members only, to whom a formal Notice and Agenda have been sent.

Other delegates and visitors are cordially invited to attend to hear the Presidential Address, which will be read at the opening of the Meeting at 3.30 p.m.

7.30 p.m. **Reception at the City Chambers**

By invitation of the Lord Provost and Corporation of Edinburgh.

(See "Arrangements and General Information." Invitations are limited and admission will be by invitation card only).

THURSDAY, 2nd OCTOBER

10.00 a.m. *Second Conference Session*

Chairman: J. Cameron Smail, O.B.E., F.R.S.E., Principal, Heriot-Watt College, Edinburgh.

The Work of Government Departments in Relation to Smoke Prevention

(1) The Department of Scientific and Industrial Research.

Combustion Research and Smoke Measurement: paper by T. F. Hurley, O.B.E., B.SC., and R. H. Rowse, B.SC., of the Fuel Research Station, D.S.I.R.

Atmospheric Pollution Research: paper by A. R. Meetham, M.A., D.PHIL., Superintendent of Observations, Investigation of Atmospheric Pollution, D.S.I.R.

(2) The Ministry of Fuel and Power.

Paper by J. Edward, Fuel Engineer, Scotland, Ministry of Fuel and Power.

10.40 a.m. Discussion.

12.15 p.m. Adjournment.

2.30 p.m. *Third Conference Session*

Chairman: R. Veitch Clark, M.A., B.SC., M.B., CH.B., D.P.H., formerly Medical Officer of Health for Manchester.

The Abolition of Domestic Smoke

(1) *Opening Survey and Questions*: by Arnold Marsh, M.SC.TECH., M.INST.F., General Secretary.

(2) Replies to Opening Survey:

Gas, by D. C. Cross, M.I.GAS.E.

Electricity, by V. W. Dale (British Electrical Development Association).

District Heating, by D. V. H. Smith, M.I.E.S., M.I.H.V.E.

Solid Fuel Appliances, by W. Davidson, B.SC., PH.D. (British Ironfounders' Association).

Gas Coke, by A. F. Pollock (Solid Smokeless Fuels' Federation).

Low Temperature Carbonization, by Col. W. A. Bristow, M.I.E.E., F.R.AË.S., Chairman, Low Temperature Coal Distillers' Association.

Natural Smokeless Coals, by Donald Hicks (National Coal Board).

3.15 p.m. Discussion.

5.00 p.m. Adjournment.

FRIDAY

10.00 a.m. *Fourth Conference Session*

Chairman: Bailie John G. Banks, J.P., Chairman, Edinburgh Public Health Committee.

Grit and Sulphur Emission Problems

(1) *Review of the Present Situation*: A factual survey based on reports of present and recent cases and complaints, by V. Silver and Arnold Marsh.

(2) *Commentary on the Present Situation*: A paper on behalf of the Society's Technical Committee, by James Law and G. W. Farquharson.

(3) *Progress in Dust and Sulphur Oxide Removal during the Past Decade and Review of Future Possibilities*: A paper by G. Nonhebel, B.A., F.R.I.C., M.I.CHEM.E., F.INST.F. (of Imperial Chemical Industries, Ltd.).

10.45 a.m. Discussion.

12.15 p.m. Adjournment.

2.30 p.m. *Fifth Conference Session*

Chairman: The Rt. Hon. Lord Sempill, A.F.C., F.R.Aë.S., F.I.P.E.

The Price of Smoke

Smoke and Health: Paper by Sir Alexander Macgregor, O.B.E., M.D., LL.D., F.R.F.P.S.G., formerly Medical Officer of Health for Glasgow.

2.50 p.m. Discussion.

3.30 p.m. *Atmospheric Pollution and Visibility*: Paper by Dr. C. E. P. Brooks (Meteorological Office of the Air Ministry), presented by Dr. W. A. Harwood (Meteorological Office, Edinburgh).

3.45 p.m. Discussion.

4.15 p.m. To consider any resolutions previously submitted.

4.45 p.m. Votes of thanks and closing announcements.

5.00 p.m. Close.

Friday Evening

7.00 p.m. Conference Dinner at the North British Hotel.

(See "Arrangements and General Information." Accommodation limited and by ticket only).

SATURDAY, 4th OCTOBER

Motor Coach Tour

9.30 a.m. Coaches leave from the Mound, Edinburgh.

12.00 noon Lunch at Callander.

2.15 p.m. Halt at Loch Earn.

5.00 p.m. Tea at Crieff.

7.30 p.m. Arrive back at Edinburgh.

(Itinerary: Linlithgow — Stirling — Doune — Callander — Loch Lubnaig — Lochearnhead — Loch Earn — St. Fillans — Crieff — Gleneagles — Glen Devon — Rumbling Bridge — Kincardine — Edinburgh.

(See " Arrangements " and Reply Form).

Previous Conferences of the Society

1929 Buxton
1930 Leicester
1931 Liverpool
1932 Newcastle-upon-Tyne
1933 Sheffield
1934 Glasgow
1935 Bristol
1936 London (Science Museum)
1937 Leicester
1938 Cardiff
1943 London
1945 London
1946 Brighton

Programme Notes

The five conference sessions have been planned to cover as wide a field of smoke prevention interest as possible—organization, the domestic problem, industrial pollution, research, the fuel efficiency campaign and fuel policy, and the consequences of smoke. A note on the subject and purpose of each session may be given.

Area Organization. This session will survey the Society's Divisional organization, the position and work of the Regional Committees, and the question of co-ordination between the Committees and the Divisions. It is hoped that the discussion will help to dispel any confusion about the two forms of organization and that it may point the way to further progress.

The Work of Government Departments. This session will be of considerable interest both in the accounts that will be given of research work and atmospheric pollution investigation carried out at the Fuel Research Station, and in showing how the fuel efficiency and other work of the Ministry of Fuel and Power links up with and assists the movement for smoke prevention.

Domestic Smoke Abolition. This session will have an unusual form. There will first be a survey on behalf of the Society, outlining what is needed for the progressive abolition of domestic smoke, and asking about 40 questions to the industries that can supply the ways and means to achieve this objective. Representatives of the industries will then reply to the opening survey, after which the theme will be developed in open discussion.

Grit and Sulphur. Attention is to be focussed at this session not on industrial smoke in general, but on the specific problems of the emission of grit and ash, and, particularly from large installations, of sulphur gases. The seriousness of the present position will be first outlined in a factual report by the Society, which will be followed by a critical commentary on the situation on behalf of the Society's Technical Committee. Finally, a more technical paper will describe the systems and appliances that are available for the control of these pollutants.

The Price of Smoke. Two of the most serious consequences of smoke will be discussed at the final session. Although some members may be familiar with the facts about smoke and health and also about the question of visibility as it is affected by smoke, especially in relation to flying, there will be many newcomers to the conference who will not yet have had an opportunity of studying these subjects. In addition such a session is of particular value in drawing public attention to the conference and the problems of smoke.

Gibbs, Bamforth & Co. (Luton) Ltd., *The Leagrave Press*, Luton and London.

A1

NATIONAL SMOKE ABATEMENT SOCIETY

Atmospheric Pollution in Great Britain

By

C. E. P. BROOKS, D.Sc.

OF THE METEOROLOGICAL OFFICE

Presented at the Conference of the Society held in Edinburgh, October 1st to 3rd, 1947, and reprinted from the *Proceedings* of the Conference

Price **1/-**

CHANDOS HOUSE, BUCKINGHAM GATE, LONDON, S.W.1

Atmospheric Pollution in Great Britain

in relation to the burning of Coal

By C. E. P. BROOKS, D.Sc.,
of the Meteorological Office

THE amount of smoke and dust in the atmosphere is a matter of general interest because of its effect on the life of the whole community. Unfortunately the distribution over this country of impurity actually suspended in the atmosphere is not well-known, especially in the country districts where it is small. In studying the geographical distribution of pollution over Britain, therefore, it was necessary to use instead, the much simpler and more widely distributed measures of the total deposited matter collected in pollution gauges. Since a large proportion of this consists of relatively heavy particles which are deposited near their sources, while the suspended impurity consists mainly of finer particles which are carried further afield, the result is probably to paint the towns blacker and the neighbouring countryside less black than is really the case.

For many years measurements of atmospheric pollution have been made by means of pollution gauges at a constantly growing number of stations in Great Britain, and published in the Annual Reports of the Advisory Committee on Atmospheric Pollution, issued by the Meteorological Office from 1915 until 1926, and subsequently by the Department of Scientific and Industrial Research. When these data had been extracted, it was found that the figures were high near the centres of large towns, and usually decreased rapidly to the west and south-west, more slowly to the east and north-east. In each district there is a general level of pollution, which varies from one part of the country to another, and superposed on this, are a number of sources of local pollution represented by the large towns. It seemed desirable to discuss these two elements, "country" and "town" pollution, separately.

To represent country pollution, those places were selected which are either in open-country well away from large towns or industrial centres, or lie some miles to the west or south-west of the nearest source of pollution. These figures were plotted and lines of equal "country" pollution were drawn over most of England and Southern Scotland (fig. 1). There is unfortunately a complete lack of information for Wales, south-west England, Sussex, Kent and East Anglia. This map shows, as would be expected, that the air is cleanest in the west and south. The station with the smallest average deposit is Loggerheads, which lies 12 miles to the south-west of Stoke-on-Trent, with open-country to the west. Here the mean annual deposit over two years was 23 metric tons per square km., and this figure rises to about 55 tons near the three great smoke-producing centres of central Scotland, the manufacturing districts of Lancashire and Yorkshire, and the London area.

The effect of large towns on the amount of deposited pollution is very local In a few cases, sufficient gauges have been in operation to enable maps to be drawn with a fair degree of confidence, and these show the combined effects of the prevailing winds and topography. Thus the industrial belt of central Scotland (fig. 2) shows a high concentration of smoke along the Clyde Valley, especially to the east, a rapid decrease to the south and south-west and a slower decrease to the north. Six miles to the south the average has fallen to 37 metric tons, while some 30 miles to the north, in open country, it is still as high as 43 to 55 tons.

Manchester and Salford (fig. 3) show a much more complex distribution owing to the presence of smaller manufacturing areas on all sides except the east. There is an area of clean air to the south, and also indication of a rapid decrease of pollution eastwards. The latter feature, if correct, is probably caused by eddies on the windward side of the Pennines.

By combining in one map all towns (except London) which had one station at the centre and others at different

distances from it, and expressing pollution at the latter as percentages of that at the centre, it was possible to construct a generalized picture of smoke pollution in a British town (fig. 4). This shows that though the maximum deposit is displaced eastwards by less than half-a-mile, the whole area of heavy pollution is elongated towards the east.

This conclusion can be compared with the results of detailed investigations of smoke pollution around Leicester, obtained by the use of smoke filters instead of deposit gauges, described in

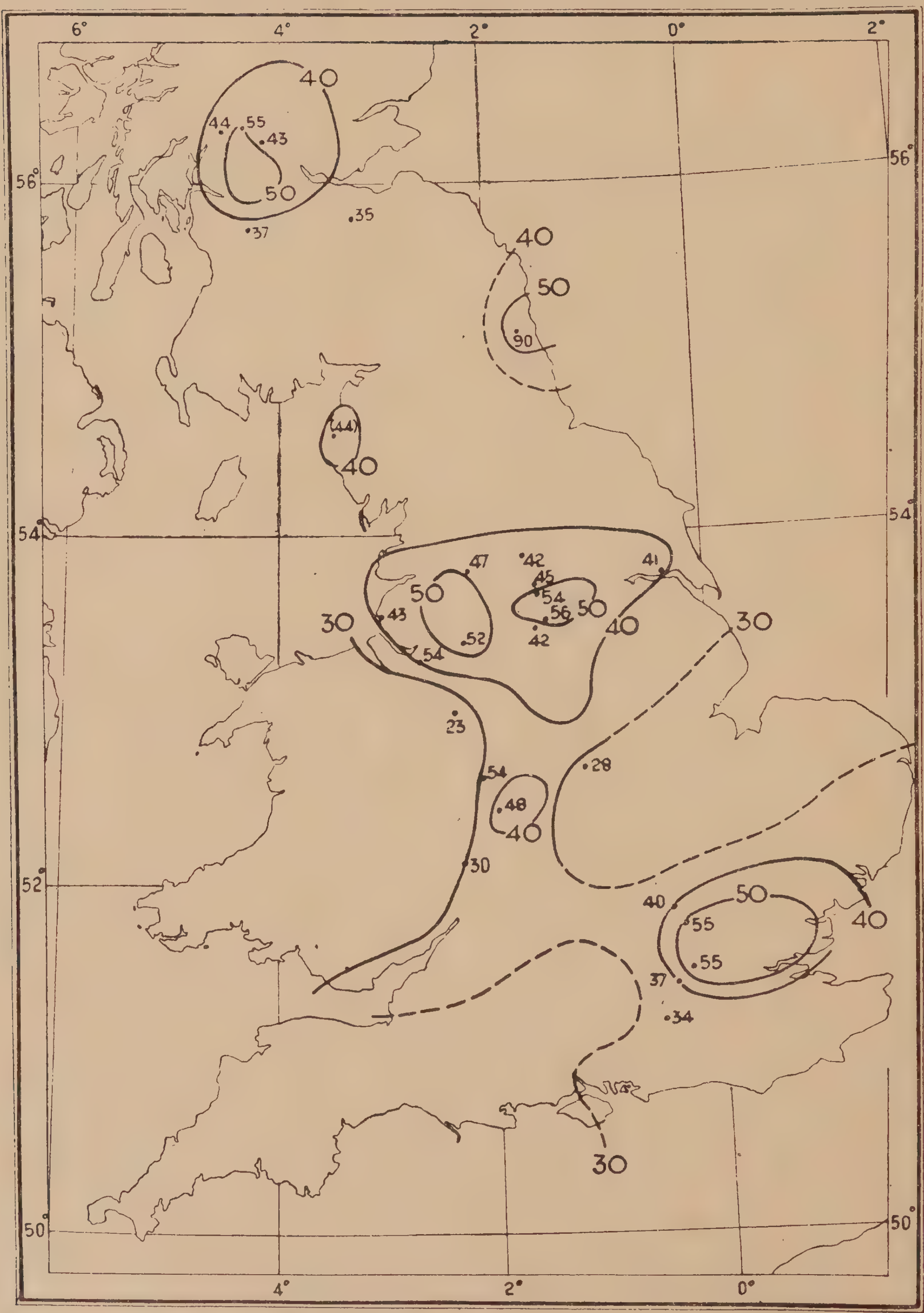

Fig. 1. Sketch map to show distribution of total solid deposits (metric tons per sq. km.) per annum, over open country and to windward of main centres of pollution.

Atmospheric Pollution Research Technical Paper No. 1 of the Department of Scientific and Industrial Research, published by H.M.S.O. in 1945. These give a measure of the suspended impurity as compared with the deposited impurity recorded by deposit gauges. Similar measurements were also made of sulphur dioxide. The greatest concentration of smoke and sulphur dioxide is invariably

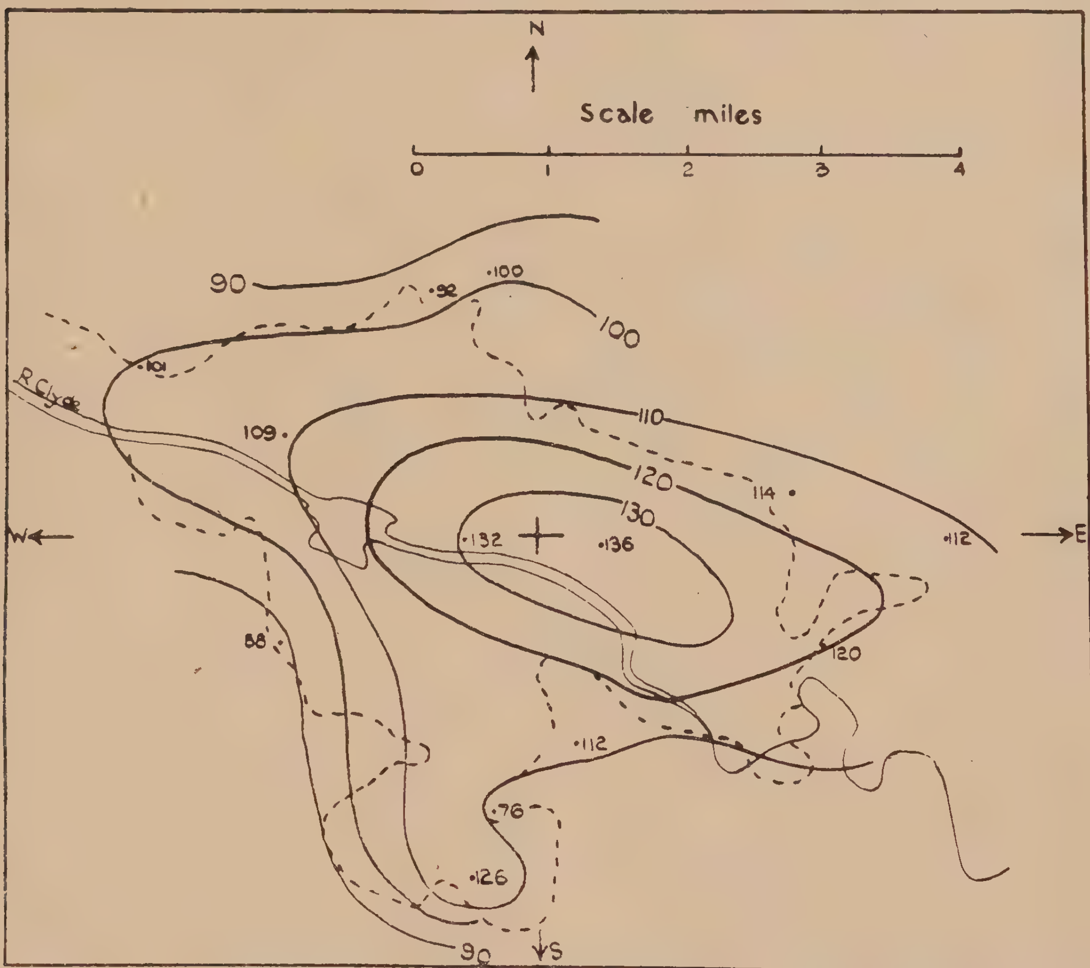

Fig. 2. Glasgow. Solid deposits in metric tons per sq. km.

to be found at the centre of Leicester, but in the outer suburbs there is much more suspended pollution on days when the wind blows from the centre of the city than on other days.

As a means of comparing the amount and distribution of deposited pollution with the consumption of coal, figures of the latter were kindly provided by the Ministry of Fuel and Power. These included a specimen week of industrial supplies and specimen year of domestic supplies; they were sorted out and plotted on large-scale maps divided into 10 km. squares by Dr. Willatts at the Ministry of Town and Country Planning. Some data published by Dr. A. Parker showed that domestic consumption produces on the average about twice as much smoke per ton of coal as industrial consumption. The industrial consumption in each 10 km. square was accordingly halved and added to the domestic consumption, the resulting figure being termed the "pollution-consumption." These figures were plotted on a smaller scale map, but they were rather irregular, depending on the distribution of townships of moderate size. To obtain a more generalized map of the sources of pollution, the figures were smoothed by replacing that for each 10 km. square by the mean of nine squares of which it is the centre. Fig. 5 is a map based on these generalized values, which represents the number of tons of "pollution-consumption" per square km. This map bears a fairly close resemblance to fig. 1, the centres of pollution at Glasgow, Newcastle, Manchester, Leeds, Birmingham and London all standing out on both charts, but the observed deposits

all show some displacement towards the east and north-east due to the prevailing winds.

The consumption of coal is not the only source of the atmospheric pollution which finds its way into the deposit gauge; vegetation, refuse, wear of roads and buildings, peat and wood fires (excluding light airs), must bring an appreciable amount of pollution. From a comparison of the deposits at seven country places with the duration of winds blowing from sources of pollution, it was estimated that the amount which would be recorded by a gauge far removed from all consumption of coal would be

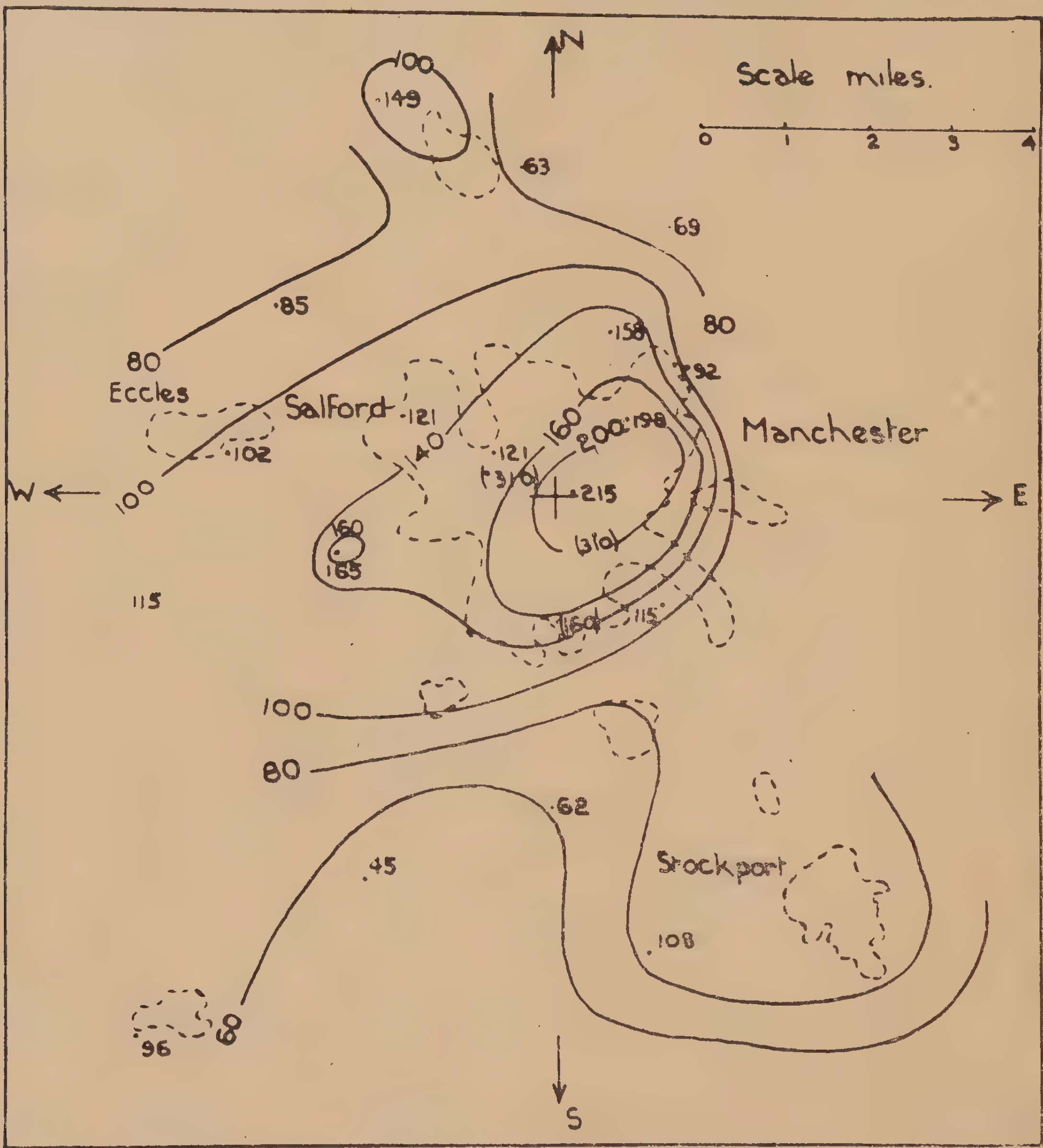

Fig. 3. Manchester and Salford. Solid deposits in metric tons per sq. km.

and other factors each contribute their quota. It is interesting to estimate the contribution of these additional sources to the total deposit.

There is no pollution gauge in England in such a position that we can regard the deposit as derived entirely from sources other than the consumption of coal. The nearest approach is Loggerheads, but even here easterly winds, which blow for 11 per cent. of the time about 17 tons per square km. a year. We may call this figure the "country pollution."

There is no direct means of estimating the quantity of deposits in towns resulting from other sources than the burning of coal. In towns there is less bare soil than in the country, but on the other hand there is more wear of roads and buildings and more household dust. We may regard the figure of 17 tons so

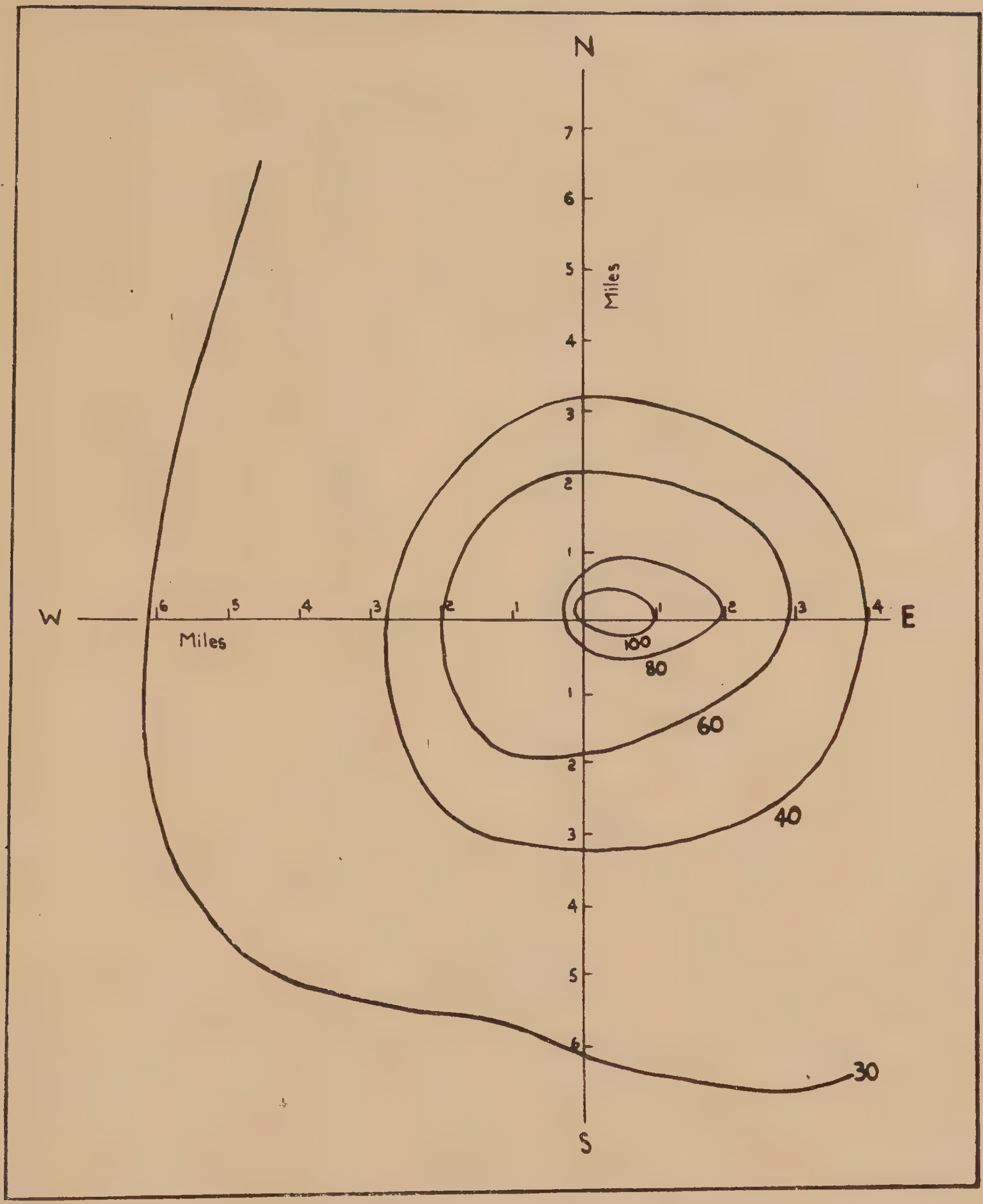

Fig. 4. Composite map of pollution expressed as a percentage of that at the centre of a town.

roughly applicable to town as well as country.

We can now make an estimate of the amount of solid deposits over England, and the amount resulting from the burning of coal. The calculation is shown in the following table:

Taking London as an example, the built-up area measured on a large-scale map is 1,100 sq. km. The average solid deposit at 18 stations in London is 101 tons per sq. km., giving the total deposit as 11,100 tons. Allowing 17 tons per sq. km., for "country"

	Area Sq. km.	*Solid deposits tons per sq. km.*	*Total deposits tons*	*Deposition from coal consumption tons*
London... ...	1,100	101	111,100	92,400
91 other towns...	3,860	78	301,080	235,460
Country ...	123,900	33	4,088,700	1,982,400
Total	126,860	35	4,500,800	2,310,260

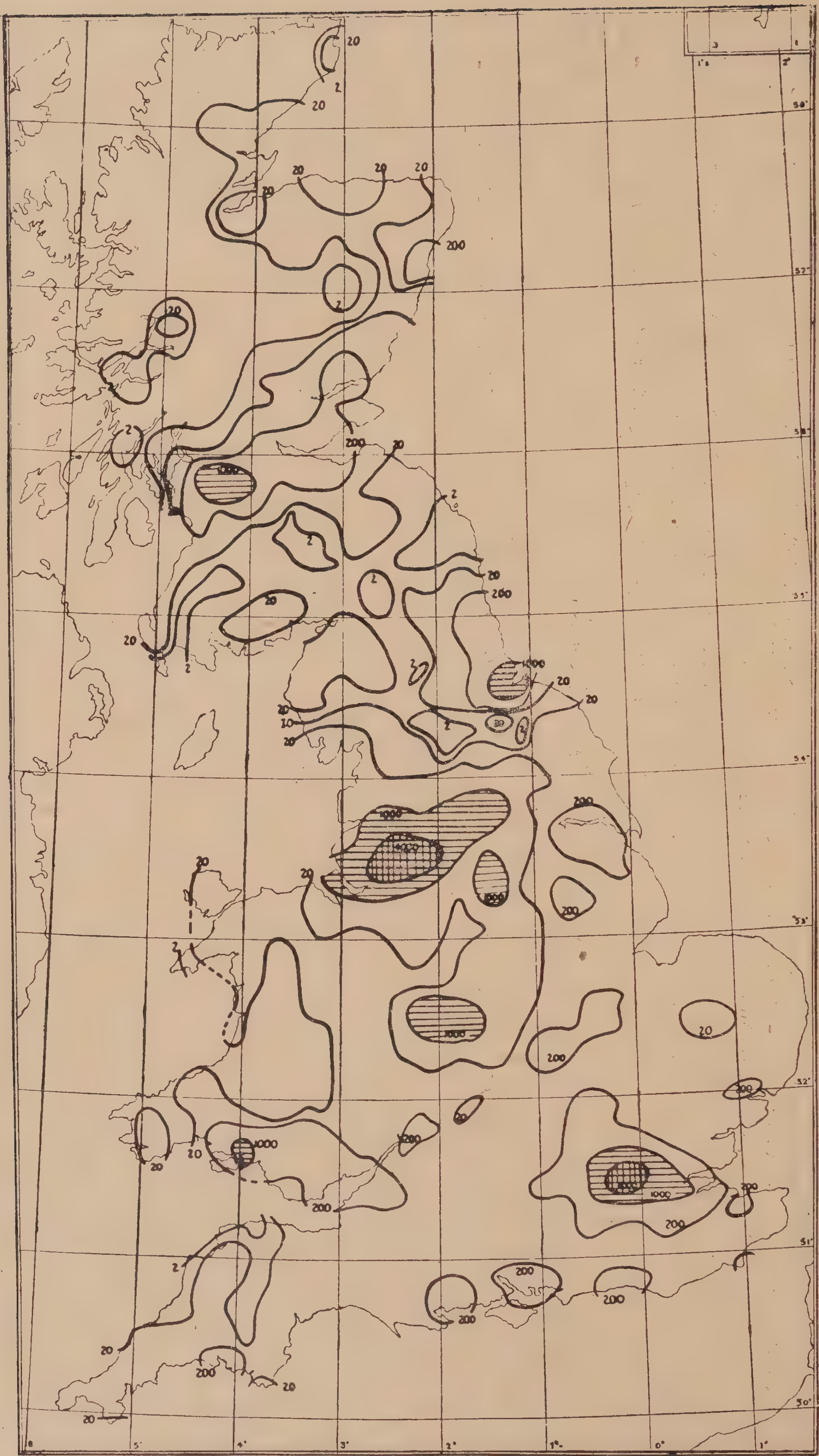

Fig. 5. "Pollution-consumption" in tons per sq. Km. per year, generalized.

pollution, we find that the latter amounts to 18,700 tons over the whole area. The remainder, 92,400 tons, is due to the consumption of coal. Similarly, the areas of 91 other towns were measured and the average deposit found for those for which figures were available. The average solid deposit over the country away from towns was estimated from fig. 1.

This table shows that in the larger towns the burning of coal is responsible for by far the greater part of the deposited impurity, more than 80 per cent. in London and nearly 80 per cent. in other large towns. On the other hand, even in the country away from large towns it is estimated that practically half the deposited impurity springs from coal consumption. Most of this is probably carried from the towns, but some of it is no doubt due to minor local sources of pollution; in fact, the presence of a deposit gauge itself implies local habitation. Over England as a whole it seems probable that a little more than half the total deposit results from the burning of coal and the remainder from other sources. It is not practicable to make similar calculations for Wales and Scotland, but in those countries it is to be expected that "country pollution" exercised the dominant effect. The area of the country is so large compared with the combined areas of the towns that this result implies that the larger part of the products of combustion of coal in towns is not deposited within the towns themselves, but is carried by the winds into the open country; some of it no doubt escapes to sea. The deposits in town naturally include a larger proportion of heavy carbonaceous and mineral particles, and a smaller proportion of such constituents as sulphur (in the form of sulphates in solution) than that in the country.

The effects of this smoke pollution on the life of the country is felt in many directions. It cuts down the hours of bright sunshine especially in winter when sunshine is most precious. Figure 6 is a cross-section of London, which shows that London's coal consumption cuts down the sunshine by about 100 hours in the three winter months. In the year as a whole, the loss is 300 hours. Even when the sun is shining, its rays are enfeebled, so that the total loss of heat and light must be very large. Another effect of smoke pollution is to decrease visibility. Smoke alone rarely causes dense fog, for which water-droplets are needed, though the addition of smoke makes London fogs much more unpleasant. But where the smoke pall is thick, there is a persistent haze which limits visibility to a few miles. This is shown in fig. 7, which shows the average number of days in the year with visibility less than $6\frac{1}{4}$ miles at mid-day. The figures range from below 50 in the clearest parts of the country to above 150 in the industrial areas of Glasgow, Lancashire, Yorkshire and Birmingham, and above 200 in Manchester and London. The similarity to figures 1 and 5 is very striking, and shows that the areas of poor visibility are directly connected with the burning of coal.

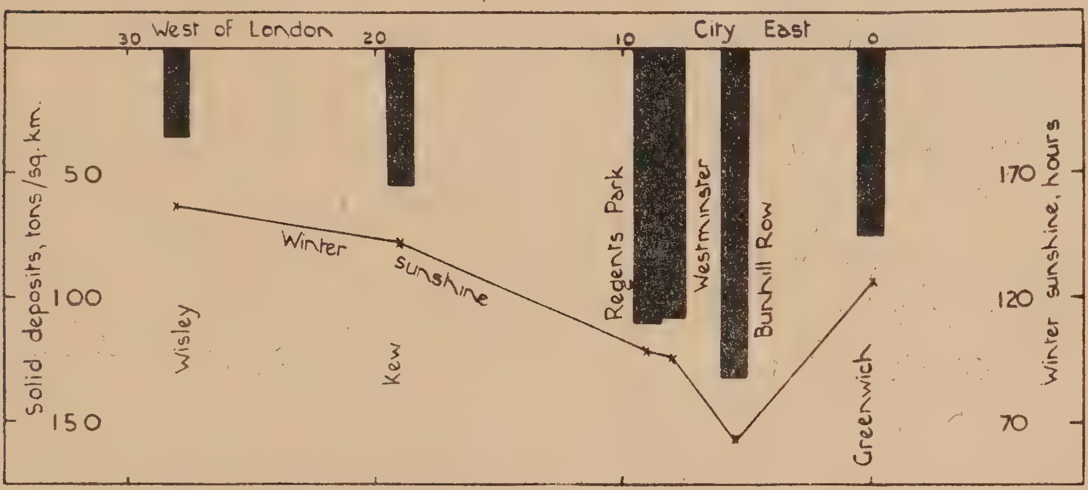

Fig. 6. Section across London, West-East, to show how pollution affects winter sunshine.

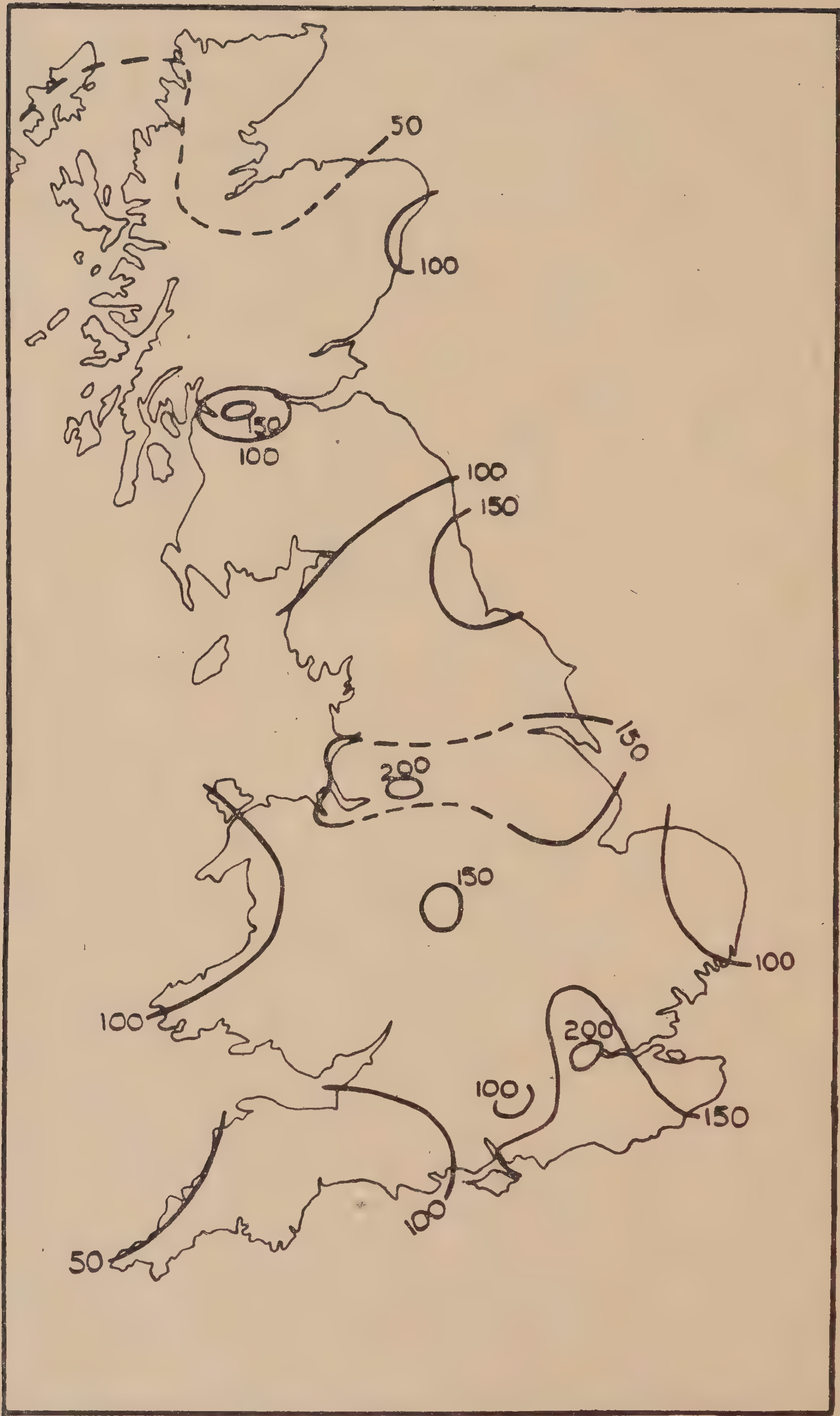

Fig. 7. Frequency of visibility less than 6¼ miles at 13h. Days per year.

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NATIONAL

SMOKE ABATEMENT SOCIETY

PROCEEDINGS of the CHELTENHAM CONFERENCE 1948

Price : 3/6d.

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29th SEPTEMBER to 1st OCTOBER
1948

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CONTENTS

The Conference was opened on September 29th by His Worship the Mayor of Cheltenham, Councillor H. T. Bush, J.P. The Sessional Chairmen were the retiring President, Sir George Elliston, M.C., D.L., Mr. D. L. Lipson, M.A., Member of Parliament for Cheltenham, and Alderman Clara Winterbotham, J.P., Deputy Mayor of Cheltenham.

PRESIDENTIAL ADDRESS

By SIR GEORGE ELLISTON, M.C., M.A., D.L.

DURING the war the Society naturally had a rather lean time, but it kept itself together, and by quiet discussion and study laid the foundations for the new policies for smoke prevention that are now finding their way into Government reports and on to the statute book. Towards the end of the war it became clear that so much had to be done during these post-war years, and so much more interest began to be taken in the Society, that a brand new constitution became necessary. This came into force in 1946, and has been most successful, both in helping to improve our financial position—which was vitally urgent—and in ensuring a stronger and more representative Executive Council.

I had the pleasure of becoming the first President to be elected under the new rules, one of which, however, lays it down that one cannot remain in that office for more than two years. So, to my own personal regret, this address must be the last I shall be able to make to you from the Presidential Chair. But it is a privilege to make way for Lord Simon of Wythenshawe, who has for so long been so closely associated with our movement. Although you will all know him for his great work on housing and as Chairman of the Committee that published the Domestic Fuel Policy report, to which I shall refer again, perhaps not so many will be aware that he was the first honorary secretary of one of the Society's parent bodies, the Smoke Abatement League of Great Britain, and author with Miss Marion FitzGerald, of the book published soon after the first world war, " The Smokeless City."

My term of office has been a most happy one, not only because I have enjoyed the close association with you all at conferences and meetings of the Council and its committees, but because the last two years—or more precisely, two and a half years—have seen some of the most important advances yet made towards the ending of the smoke evil, and certainly the most satisfactory growth of the Society's own position and standing. The whole picture of the smoke abatement situation has changed radically during the thirty months I have been your President.

When I say that we have made important advances towards the ending of the smoke evil I do not of course imply that we have seen any substantial improvement in the present conditions of the atmosphere. That would not be true, and for many reasons we are forced to try to be patient in waiting fo enjoy the fruits of our labours. Although the fruit is not ripe, the tree is at last strong and healthy, with firm spreading roots ; it is in good leaf and there is a vigorous growth of flower buds.

I do not intend to attempt any account of all that has happened during this time, and will refer only to one or two of the more significant matters. Foremost of all, perhaps, is the report on Domestic Fuel Policy of an advisory committee of the Ministry of Fuel and Power, under the chairmanship of our incoming President, Lord Simon of Wythenshawe. Although the report necessarily covers a wider field than smoke prevention it shows unmistakeably how the whole problem of the domestic uses of fuel, both from the viewpoints of national policy and of the householder, is firmly and inextricably

bound up with the policy of abolishing smoke from our homes. It recommends a policy that will lead step by step to this objective, and it is most gratifying that this policy should be so very similar to that of the Society.

Of course, reports can be presented to Ministers and Governments, but it does not always follow that they are acted upon. Indeed, in our own field, it may be recalled that one of the criticisms of the Newton Committee in 1921 was that "no government has, for many years, taken any action with the exception of appointing committees, whose labours have had little or no result."

However, it was soon stated in Parliament that the Government did, in general, accept the recommendations of the Simon Committee, and there have been many signs since then that, despite all the difficulties and frustrations of the times, it is firmly intended to proceed with the plans proposed.

And I think I may say that one of the most real, and certainly one of the most pleasurable of these signs is the presence with us at this conference to-day of the Minister of Fuel and Power himself. I do not know what he is going to say to us about these plans, but I am quite sure he is not going to disappoint us, cautious and discreet though Ministers of Fuel and Power must always be.

During these two and a half years we have also seen action based on policies advocated by the Society. We have seen new measures for preventing smoke approved by Parliament and placed on the statute book. True, they are so far only local Acts, but they embody new principles and are most significant. There was first the new Act of my own Authority, the City of London, which for the first time in this country gives powers for the prior approval of new fuel-burning installations. Similar, though not identical, powers were then secured by Manchester, which also made history by having our own scheme for smokeless zones included in its Act. Other towns have followed and more are likely to come—and it is all leading up towards the new general legislation we now need.

I may turn for a moment to the Society's own progress during these first years of its new régime. Over a hundred new local authorities have joined it as members during that time, and it has now affiliated to it practically every large town in the country, as well as many of the smaller ones—representing well over one-half of the total population. Its income is still lamentably small for the size of the task it is so zealously tackling, but it is comforting to note that its subscription income has risen from £1,300 in 1944 to £3,400 in 1948. But compare this slender sum with the figures of what we really need given in the paper by Mr. Hardern to be discussed to-morrow, which you have no doubt already carefully studied. What is happening is that the Society is doing rather more than it can really manage or afford, and that everyone is expecting it to do a great deal more. It wants to do more, of course; a great deal more; but at the moment it is painfully embarrassed as a direct result of the success of what it has already done.

There are now three divisional organizations of the Society, all active and making good progress, and soon there will be more. We have excellent friendly liaison with the Regional Committees of the local authorities, and it is a sign of our maturity and of the responsible position we have achieved that our relations with Government departments, and with scientific and technical bodies, and of course with our own local authority members, should be closer and firmer and more productive of useful co-operation than ever before.

We must of course always recognize that we have still a long way to go, and that the road will not be an easy one, before our objective is gained and we can sit back and relax—or disband. But at the same time we must remember that we are moving quite steadily along the road, and that although the pace is still too slow it is quickening.

We must not, however, lose sight of the most serious factor of all that concerns us, which has continued

without cessation during the two and a half years of my Presidency—the waste and damage due to smoke that has gone on, and the enormous loss of coal involved in the production of this smoke. This yearly loss of fuel, our D.S.I.R. friends estimate, is equivalent to 2½ million tons of coal, and to it must be added the greater loss contained in the invisible gases formed with smoke. From the fuel economy point of view smoke is like an iceberg—the more serious part cannot be seen. As we were told at Edinburgh last year, these losses may be several times greater than the loss of visible smoke, so that there is a total loss equivalent to about 10 million tons of coal a year. If this estimate is correct, during my term of office some 25 million tons of precious fuel have been mined at great cost, transported at more cost—and then thrown away. How excellent it would be if we could recover it and present it to the Minister!

I cannot close this Address without paying tribute to two of the outstanding workers for our movement. First of these is Mr. Charles Gandy, who presides over the Council with so much tact and sound judgment. For years we have had the benefit of his leadership and he has never stinted the valuable time he has spent in our service. His patience and charm of manner make it very pleasant to submit to his rulings even when there is a clash of opinion in our discussions. Secondly, I am sure I may express on your behalf our gratitude to Mr. Arnold Marsh for his devoted service to the Society. He not only conducts our daily affairs with unfailing efficiency, but as Editor of *Smokeless Air* he has done much to educate public opinion on the problems of smoke abatement. In addition we rely on him as skilful liaison officer between the Society, Government departments, municipal authorities, and industrial organizations. Above all, we are grateful to him for his authorship of "Smoke: the Problem of Coal and the Atmosphere," which is likely to remain as the authoritative textbook of our movement for many years to come.

In conclusion, as one who has many interests in the fields of public health and the prevention of disease, I should like to direct your attention to the words of the Medical Officer of Health for the West Riding of Yorkshire, Dr. Brockington, who in a recent report pointed out, in an admirably direct fashion, that "it is a contradiction of the principles of positive health when the air that people breathe contains dust and soot capable of causing solid deposits to the amount of upwards of 150 tons per square mile each year," and even more firmly added: "it is the negation of preventive medicine to establish hospitals a large proportion of whose beds would be redundant in a clear atmosphere."

That surely is the very heart of our case for the abolition of smoke, and I do ask you all to consider and appreciate its significance and to bring it home to your own authorities as strongly and as persistently as you possibly can.

ADDRESS

by

The Rt. Hon. HUGH GAITSKELL, M.P.

Minister of Fuel and Power

THE Society made a particularly wise decision in my view when they chose Cheltenham as the place at which to hold this Conference. For I have always regarded Cheltenham as one of the cleanest cities in the country. My memories of it go back a long time, so long indeed that they are now clouded. But through the clouds stands out the picture of very white buildings standing on each side of broad streets. Perhaps for this reason too it has always seemed to me a town with a peculiarly continental flavour, though whether the residents prefer stoves to open fires I cannot say. It is a pleasure to me to come back here because of my family associations with it. My grandfather, who was born two years before the battle of Waterloo, lived, I believe, for the last half of his life here. My father and his brothers were all educated here; aunts and cousins and even my own family were for a short time citizens of this town.

Mr. President, you have told us of the progress made by the Society in the past two years. I congratulate you on having held office in a period of substantial advance during which reconstruction has taken place, membership increased and the whole activities of the Society have been enlarged. Of these activities I would refer particularly to the extraordinarily interesting survey by Mr. Cousin on the sources and incidence of atmospheric pollution. This seems to me objective, constructive and adorned with a very pleasant, dry humour. I shall touch later on one or two of the points made by Mr. Cousin.

I should also like to express my pleasure at the election of Lord Simon of Wythenshawe as your new President. He and I are old friends. Of course, he is peculiarly well suited to occupy this position, partly because of his earlier work on smoke abatement but still more because of his work as Chairman of the Committee on Domestic Fuel Policy. Perhaps one might add that it seems exceptionally appropriate that the Chairman of a Society whose aim is to purify the atmosphere of smoke and soot should be a man who, as Chairman of the B.B.C. is also concerned that the ether should not be contaminated in other ways.

There are, I think, two main arguments in favour of what is called smoke abatement. There is the economist's argument and there is the technician's argument. The latter is one which particularly concerns me as Minister of Fuel. For it is part of my statutory duties "to promote economy and efficiency in the use of all forms of fuel and power" and it so happens that fuel efficiency and smoke abatement go hand in hand most of the way. To this subject I shall return later but I want, first of all, to refer to what I have called the economist's argument. Perhaps I may claim a right to do so since long, long ago I used to make my living teaching economics.

The economist's case is this. When a factory or private house pours out smoke it proceeds to defile and obscure the atmosphere, to discharge grit upon its own and other people's premises

and to create dirt and corrosion. This process imposes costs upon the rest of the community which the person who actually owns the factory or the house does not have to pay. Because he does not have to pay them, these costs are not taken into account when the decisions what fuel to burn, what appliance to instal and therefore possibly what articles to produce, are taken. The result, says the economist, is that wrong decisions from the point of view of the community are taken. If these additional costs had really been counted in as they should have been, you would get a result which more accurately reflected the wants of society. Perhaps I can elaborate this by some illustrations. Not long ago I visited a brewery and one of the things which most impressed me was the extraordinary amount of trouble taken to keep the place spotlessly clean—almost everybody seemed to be engaged on cleaning. One might even say there was water, water everywhere, except that it would be a little unfair to the brewery! The Manager who showed me round told me that, in fact, about half their labour costs were incurred through the necessity of keeping everything perfectly clean. Now these costs were, of course, paid by the brewery and passed on to the consumer in the price of the beer. They were attached—as it were—to the article in the production of which they had arisen.

It so happens that that brewery also had a very efficient heating system. I may say that they used, apart from the anthracite they required for malting, 90 per cent. opencast coal and yet had a very high fuel efficiency. Nor did I see any signs of smoke pouring out of the chimneys. But to judge by Mr. Cousin's report this is not always the case. The brewery might have had a very inefficient system. It might have been pouring out smoke and in so doing adding heavily to other people's costs, causing them to spend additional money in painting their buildings, washing their linen, and cleaning their equipment. But the brewery does not have to pay for this. There is, in other words, a social cost which is paid for by the whole community, while no bill is sent in to the real sinners, who therefore continue in their sin with impunity. I see that among the worst offenders there are said to be a number of laundries. From the strictly economic point of view of their own interests I suppose there may be something to be said for it but certainly not from the point of view of the rest of the community. Some of the collieries themselves are, undoubtedly also sinners in this respect. Somebody wrote me a letter the other day drawing my attention to this—which was hardly necessary because I have to travel fairly regularly through the coalfields and know what they look like—but he asked " in your address to the Smoke Abatement Society I am not sure whether you intend to take the part of Satan rebuking sin or in praising the efforts of your colliery experts." Well I think the metaphor is a little mixed because for this purpose at any rate I prefer to regard myself as more like the Archangel Gabriel. It is, of course, true that the collieries do frequently have to make use of their inferior fuel, more inferior even than they supply to other people. Nevertheless, we certainly should not be satisfied without making sure that more efficient methods of firing can produce an improvement, and it is hardly possible to applaud the very reasonable conclusions of Mr. Cousin that " the plea of inferior fuel is rather over-done and is likely to be used as an excuse for inefficiency for some time to come," and then to go and exempt collieries from criticism on the grounds that they have to burn a lot of muck.

So much for industrial smoke. The economist's argument on domestic smoke is much the same. When you burn coal in an open fire with peculiar inefficiency at home you may not be running a business, but the damage that you do to other people is just the same. Your habits may involve you in heavy expenditure which, nevertheless, for the sake of the pleasure you obtain you are willing to incur, but this is no justification for imposing costs upon other people when you do not have to meet

the bill yourself. I once had some friends who were very fond of cats and these cats had a habit of sharpening their claws on the sofa and chair covers, so that the covers had constantly to be renewed at considerable expense. This was all right. It was part of the cost of keeping the cats, just like the cost of feeding them, and it was paid for by my friends, but when you pour smoke out on other people's linen it is a different story!

And apart from the more obvious incidence there is the imponderable element, the loss of sunlight which, heaven knows, in this country is in sufficient short supply—to use the current jargon—with the consequent effect on health both physical and psychological to which, Mr. President, you have referred.

All this, the economist argues, leads to the conclusion that, in principle, here is a case—which even the most rigid laissez-faire die-hard could not demolish—for intervention by society, for action by the community, so as at least to impose upon those who are responsible for creating the social costs the responsibility for meeting them.

Before, however, turning to the question of action I would like to say a few words about the technician's approach to the problem.

It might have been the case that the pollution of the atmosphere by smoke was something which could only be stopped at great expense to the community. The hypothetical brewery to which I have referred—the one with the bad combustion arrangements (not the one I visited)—might have found that the expense of eliminating smoke was so great that it really preferred to pay other people for the damage caused by the smoke and continue to allow it to be emitted. But, of course, the extraordinary thing is that to stop a chimney from smoking, far from involving the individual in more expense, will, in a great many cases, actually save him money because, as you all know, smoking chimneys, particularly in industry, are often a sign of bad fuel practice. They mean that the coal is being burnt in a manner which fails to provide the maximum degree of heat.

As you will no doubt appreciate, I was somewhat embarrassed a few months ago by a certain poster which the Government issued in connection with the production drive. I am glad to say that it has now been withdrawn in favour of a much better one, but the fact that such a poster could have been issued does illustrate, I am afraid, the extraordinary ignorance which prevails on this subject. The only defence which could be put up in its favour was that people associated full production with smoking chimneys! How vividly that illustrates the great amount of educational work which still remains to be done in the field of fuel efficiency.

I think, however, we can claim that there has been most remarkable progress in the past few years. As the President has told us the Newton Committee of 1921 was rather caustic on the attitude of Governments to this problem. But even in 1945 I must remind you that Dr. Dobson, the Chairman of the Atmospheric Pollution Research Committee, stated that, as a result of the first year's work of the Fuel Efficiency Campaign alone, there was a reduction in pollution of 11 per cent. throughout the country, in comparison with the previous year. Since then, of course, the work has continued and every year our Fuel Engineers, and those who are good enough to help us in this work in a voluntary capacity, visit something like 20,000 industrial establishments a year, to advise on greater efficiency; and I have no doubt that, despite the fact that, for various reasons, there has had to be a good deal of down-grading in so far as the fuel itself is concerned, the progress mentioned by Dr. Dobson has been continued.

During the war, of course, and even now, we are limited in our efforts to improve fuel efficiency and reduce the smoke nuisance by the difficulty in getting new boiler plant. Even in this case we cannot ignore or be free from the impact of our balance of payments problem and the tremendous arrears in capital equipment in this country

which still have to be made up. And although as time goes on one hopes that capital expenditure of this kind will become easier we must, for the time being, rely rather on improvements in current firing practice. I should like to emphasize that the country now possesses in our Regional offices a force of trained stoker demonstrators, prepared to visit any combustion plant and help the operators by practical demonstrations to use their coal more efficiently and, therefore, produce less smoke. I was glad to see the reference in Mr. Cousin's report to this part of the Ministry's activities. I agree with him, however, that there are still many authorities who do not make sufficient use of our technical services.

There is another long-term project referred to by Mr. Cousin : the educational work of the Ministry in conjunction with Technical Colleges. For the first time courses for the average fireman have been arranged and, as a result, he can obtain a certificate of practical competency on a syllabus approved by the City and Guilds, London. I believe this development will be especially welcome to the National Smoke Abatement Society because it really represents an expansion, through the country, of the courses which you initiated at Glasgow and Manchester and other large towns before the war.

These new courses in boiler house practice were started in the winter of 1946. 600 students have attended lectures at 32 centres and 323 were successful in the examination. In the winter of 1947, 1171 students attended 58 courses and 712 were successful. I am bound to say the figures still seem to me far too low, but I am glad to see they are going up. I hope the Society and everybody here will do everything they can to encourage those concerned to attend these valuable courses. Before I leave the subject of industrial fuel efficiency, I must refer to a recent very dramatic example. At the moment in Berlin three members of the Ministry's staff are engaged in tuning up the power stations in the British sector and it is believed that their work will help to produce savings of up to 150 tons of coal a day that would otherwise have to be flown in by air this winter requiring about 15 planes a day.

Now let me turn to the domestic problem. This is undoubtedly more difficult—both technically, politically and psychologically. You have the fact that people like an open fire. The time may come when we are indifferent to it but it has not yet arrived. You have the fact too that the vast majority of our houses, being built some time ago, have old-fashioned grates fitted in them, which are not calculated to give the most efficient performance. Progress, therefore, must inevitably be slower in this field but although we may be impatient sometimes it must be emphatically asserted that there has been a considerable advance. Let me take the case of the new houses. We were faced immediately after the war with this position. We at the Ministry wanted the most modern appliances to be installed in these houses but the decision in such matters, of course, rests with the local authorities. We found that the local authorities were often inclined to say "we cannot get the modern appliances" and, at the same time, the manufacturers were inclined to say "we will not manufacture modern appliances because there is no demand for them." Well, by steady patient persuasive work we have now got to the stage where the manufacturers have switched over sufficiently from the old to the new models, with a result that they are producing enough to supply new appliances for all the new houses now being built. This may not sound very impressive, but when you remember that in many cases, apart from the designing, there has had to be complete new tooling-up by manufacturers, I don't think the outcome is too bad. Some people, no doubt, think that we should have used compulsion. The local authorities should, they say, have been prohibited from putting in anything but modern appliances in these houses while the manufacturers should have been prohibited altogether from producing the older

types. Apart from the fact that when the housing programme started, this was not possible because production of the improved types was not sufficient to meet requirements, for my part, I would much prefer to proceed, as far as possible, by the method of persuasion rather than compulsion. After all, people have very individual views on fires and boilers, and I do not think that it would be conducive to the success of our educational campaign if we were to force the issue at this stage. At the same time, I cannot for one moment pretend that I am really satisfied. A sample survey which we carried out, covering about 120 thousand houses built since the war, shows that only 1 in 3 have been fitted with this new equipment. I have already explained the difficulties in obtaining the new equipment sufficiently quickly but, even allowing for this, that progress is not enough. I do, therefore, urge those of you who are connected with local authorities, either as councillors or officials, to do everything you can to ensure that in the houses you build the most modern appliances are installed. I may say that some of the local authorities whose Medical Officers of Health have been pressing us for increased efforts, are the very ones who have been most backward in this matter! To me at least it seems quite incomprehensible that there should be any hesitation on the part of local authorities to incur an additional expense of, say, £10 on a house that costs perhaps £1,500, which is going to have a life of, say, 50 years, when as a result you could obtain, perhaps, twice as much comfort or use half as much fuel. The small additional cost is going to be saved over and over again and, of course, from your particular angle, there will be at any rate *less* smoke nuisance than would have otherwise been the case.

You will expect me to say something about the prospects of obtaining smokeless fuel because it is evident that the domestic smoke problem would be solved if it was feasible, and was the custom for nothing but smokeless fuel to be burnt in people's homes.

The supply of coke, of course, is related to the production of gas. Just at the moment coke supplies are easier, partly because of increased gas production and partly because in order to save gas-oil the undertakings have had to cut down their production of carburetted water gas and increase the throughput of ordinary coal gas. I must point out, however, that we are now pretty well up against the limit of plant capacity for making coal gas and to meet the peak demand this winter there will probably have to be additional production of carburetted water gas which, of course, means using more coke in the gas works. However, looking further ahead, the supply of coke will no doubt continue to increase broadly in proportion to the increase in gas consumption, that is, by about five per cent. per annum.

The Simon Report, of course, laid great emphasis on anthracite production. I am afraid the immediate position is not encouraging. On the contrary the value of anthracite as an export is so great that we are having to ask consumers, particularly those using certain grades, to substitute coke for anthracite wherever they can. Moreover, of all the problems facing the National Coal Board that of the production of anthracite is, perhaps, the most difficult. It is being mined at present at a heavy loss; the experts, I believe, take the view that only the complete re-equipment of the coalfields, involving heavy capital expenditure, can lead to the increased production and reduced costs which we all desire. The Coal Board are examining very carefully, as they must do, this whole question of long-term development, but as yet no definite decision has been reached.

One must, therefore, conclude that for the time being, we must expect bituminous coal to continue to be burnt in people's homes.

You may say, of course, "why not make them use gas and electricity?" Well, in the first place, I happen to be a strong believer in leaving consumers freedom of choice. It may well be that because gas and electricity is more

labour saving than solid fuel, there will be a continued tendency for replacements of this kind to go on. But there is a further difficulty and that is that in the case of electricity, and to almost the same extent in gas, shortage of plant is a great handicap. I cannot possibly encourage the use of more and more domestic electricity when we have not got the power stations to generate it and when additional burdens can only increase the need for loadspreading and the danger of serious interference in industrial production through load shedding.

I do not wish, of course, to deny that, from the point of view of efficiency and of smokeless combustion, the open fire is a most unsatisfactory proposition. We are now in co-operation with a number of leading local authorities testing the balance between increased efficiency and convenience which other systems can provide as against the traditional feeling in favour of the open fire. They are now building in eight centres, houses demonstrating four different systems of house heating, including one using bituminous coal. It will be extremely valuable to find out what the tenants think about these systems, while at the same time the Building Research Station is carrying out scientific experiments to measure the thermal efficiency of the appliances.

Finally, there is another possible solution in district heating. The mission to the United States last year, whose report will very shortly be published, found that by far the majority of local housing authorities over there rely on some form of district heating on their estates. Of course, again tradition comes in. Central heating is accepted in the United States far more than it is here. It is worth noting that this preference is not the result of climatic differences, since some of the places where district heating is the rule have weather almost identical with ours. I am glad myself that a number of local authorities are now starting experiments in district heating over here on their new estates. We shall look forward with interest to the results which they report.

The other day Sir Ernest Smith, so I read in the papers, called for a comprehensive national fuel policy and said that under such a policy all available fuels could be considered and guidance or direction could be given. He went on, somewhat to my surprise, to say "this matter was raised by the Institute of Fuel officially some time ago and the answer was that the Ministry of Fuel and Power had at its inception adopted the principle of devising a national fuel policy—we are still waiting for it."

I say somewhat to my surprise because I thought that I had dealt fairly fully with this subject in the speech I made on the Second Reading Debate on the Gas Bill, and I happen to know that Sir Ernest Smith was sitting in the Gallery. I can only assume, with regret, that he was so bored with the earlier part of my speech that he fell fast asleep before the end! I do not wish to recapitulate now what I said on that occasion but I would just say this: if by a national fuel policy Sir Ernest means that we at the Ministry ought to tell people exactly what fuels they are to use, then I am afraid he is going to be disappointed for it would be contrary to the principle that consumers must have freedom of choice. Some people like electricity for cooking, some people like gas, some people like gas fires, other people like an open fire, some people like central heating, other people detest it. We must really allow individual preferences to have some weight in this matter. Nor must we make the mistake of assuming that fuel efficiency in the technical sense is everything. It is not. Costs must also be taken into account. What we aim at securing is the highest degree of fuel efficiency commensurate with the capital costs involved. Comparative costs are, after all, a pretty sound criterion and I think we should do well to allow them to exert their influence.

Of course, the whole position at the moment is still affected by shortages of one kind or another. Coal and oil are both scarce and their distribution has to be controlled. Special action has to be taken to reduce the peak load on the

power stations. Lack of steel certainly holds up development in the gas industry too. The result is that we have to give a good deal of guidance and even direction which in all amounts, if you like, to a short period fuel policy —though I do not think this was what Sir Ernest had in mind.

What is wanted in the long run is not merely that consumers should be free to choose but that they should have a chance of choosing wisely. In other words we must see to it that full, accurate, and unbiased information is available. We must also see that the prices which influence their choice reflect accurately the real cost of producing, distributing and installing both the appliances and the fuel.

And this brings me back to smoke abatement. For here we have a case where, alas, there is far too much darkness of mind, where ignorance must be dispelled in the interests of consumers themselves, where too, as I have argued, heavy social costs arise which are not and perhaps never can be reflected in individual prices. And this means that as I intended to convey in the speech to which I have referred, it must inevitably be a part of our fuel policy to tackle this problem of smoke pollution. Having said that, let us not jump to the conclusion that we should impose a lot more rules on people from the centre or go in for too much regimentation. The reports presented to this Conference show that already much progress is being made, both by way of education and through local government. It may be that more positive steps still should soon be adopted and I shall be happy to discuss them with your representatives. But whatever the outcome may be I am sure that we must continue to rely on the efforts of your Society and its members who have already done so much to assist the cause of fuel efficiency and whose success not only leads to a saving of our valuable coal but helps to remove from the atmosphere the poisonous mass of soot and dirt which has for so long disfigured our towns and blocked the sunlight from us.

INTERIM REPORT

On

National Survey of the Sources and Incidence of Atmospheric Pollution

By A. J. COUSIN, M.Inst.F.

1. General

At the Annual Conference of the National Smoke Abatement Society in October, 1947, at which 450 representatives of local authorities were present, the following resolution was passed:

> "That the Executive Council be requested to take the necessary steps to undertake a nation-wide survey of the sources and incidence of atmospheric pollution, and that local authorities be urged to co-operate with this object in view."

1.1. The Executive Council decided to proceed by addressing to every local authority a questionnaire in two parts, general and detailed, on two forms, green and yellow respectively, with which many will be familiar.

1.2. It was with some diffidence that the Executive Council adopted this course in that it laid an additional burden upon overworked staffs preoccupied with their statutory duties. Moreover, the Society, being a voluntary body, had no authority to call for a return of this character, and the value of the Survey would depend entirely on the extent to which Local Authorities and their officers would be prepared to co-operate. A further difficulty would be likely to arise from the impossibility of establishing any common standard of assessment of atmospheric pollution, unless its measurement were undertaken by scientific methods.

2. The questionnaire was addressed to the following bodies in England and Wales and in Scotland, and replies were received from the number indicated in the second column.

	Sent to	Replies Received
England and Wales		
London County Council, City of London and Metropolitan Boroughs	30	22
County Boroughs	83	66
Municipal Boroughs	309	169
Urban Districts	572	261
Rural Districts	475	170
	1,469	688
Scotland		
County Councils	34	12
Royal, Parliamentary and Police Boroughs	195	61
	229	72

2.1. Of the 198 local authorities represented at the Edinburgh Conference, who supported the resolution, 149 have sent in returns.

3. Immunity from Atmospheric Pollution

Of the authorities that have made returns, some 140 in England and Wales and 15 in Scotland have reported they suffer from no atmospheric pollution.

3.1. Such a conclusion arrived at by such a large number of local authorities gives cause for thought, particularly in the light of evidence that has been adduced hitherto.

3.2. At the Conference in Edinburgh last year it will be remembered, Lord

Sempill referred to an incident when his plane was parked in the open in Cornwall throughout the night, during which a slight rain fell. In the morning the plane was covered with a coating of soot, carried by the wind from the Midlands.

3.3. Mr. Entwistle of the staff of the Meteorological Office of the Air Ministry reported the difficulties attributed to smoke experienced by pilots flying over Great Britain or from Britain to the continent. Banks of smoke are frequently found at great distances from the area in which they were produced.

3.4 The late Sir Frank Baines reported on many occasions on the damage by the corrosive action of atmospheric acid to stonework of historic Abbeys in Yorkshire and in the Wye Valley far removed from any source of smoke.

3.5. In the survey under discussion, one island off the West Coast of Scotland reported that, with the wind in a certain direction, it suffered from heavy deposits of soot from a distant industrial area.

3.6. In view of the extensive evidence of the widespread dispersion of smoke and acid in the atmosphere over Great Britain, and the universality of domestic smoke, these professions of complete immunity may give rise to some pardonable scepticism.

4. Standard of Assessment

The absence of a common standard of assessment of atmospheric pollution offers a major difficulty. Where a local authority is sufficiently interested to tackle the problem scientifically and install solid and sulphur dioxide gauges, the way is clear; but where the authority relies on the unaided impressions of its officers, very wide differences in outlook are apparent.

4.1. It is well-established that domestic chimneys are responsible for at least half of the general atmospheric pollution in Great Britain. However, unless an individual is made smoke conscious by seeing smoke issuing from chimneys resembling those with which the Central Office of Information covered our hoardings, he seems to be unconscious of the equal or greater amount of smoke issuing from the thousands of house chimneys in his area. This attitude of mind is illustrated by the tone of several of the replies in respect of areas alleged to be immune, which are quoted below :

	Population
Rural Districts	
" We have no large industrial plants to pollute air "	12,000
" No smoke-producing industries "	7,400
" No industrial premises of any size "	17,000
Urban Districts	
" Small coastal resort with no industries "	12,000
" There are no industrial premises in the area "	3,000
Boroughs	
" Non-industrial area "	24,000
" Very few industrial plants within the borough "	64,000
" Negligible owing to there being no factories "	26,000

This last town lies in a deep depression in which, in calm weather, a heavy pall of domestic smoke can be seen.

4.2. One country borough reported that it suffered from no atmospheric pollution and no useful purpose would be served by filling up the forms. Ironically enough, a photograph of this particular town was published some time ago to show a heavy pall of smoke hanging over the town. On a second approach however, the authority sent in a very comprehensive return.

4.3. Equally surprisingly, a metropolitan borough reported : " This is largely a residential area, and as such has no real problem of atmospheric pollution . . . has experienced no trouble from such pollution drifting from other areas."

The mean deposition in the area is somewhat higher than that at any of the deposit gauge stations in Newcastle-on-Tyne.

4.4. An Urban District some twenty miles from London reported : " . . . is predominantly residential and fortu-

nately it has no atmospheric pollution in any way."

The above quotation from reports from areas alleging complete freedom from atmospheric pollution are illuminating. Reports from areas heavily industrialized rarely fail to mention the presence of domestic smoke, whereas even densely populated areas frequently fail to mention smoke from domestic chimneys, but confine their remarks to public buildings, laundries and so forth.

4.5. There are, however, noteworthy exceptions as several mainly residential areas have reported that they suffer from domestic smoke only.

5. Nature of Replies by Local Authorities

Another outstanding difference is the manner in which forms have been filled up. Those from some local authorities have been completed with meticulous care, others have been dismissed very summarily, and in a few cases officers omitted to fill in the name of their local authorities.

5.1. One local authority submitted a summary of deposits in different parts of the town during working days and holidays in summer and winter, from which it was possible to deduce that over 50 per cent. of the smoke was due to that emitted from house chimneys. Comparative sulphur dioxide records indicate that over a half was produced by domestic grates, and that this was much heavier in parts of the town where old houses were still fitted with old-fashioned grates. Ultra-violet ray meters showed that the town got approximately one-third of the light that reached the immediate rural areas.

5.2. Another local authority provided a large scale map showing lines of equal solid deposition. This showed the heaviest deposition in the neighbourhood of heavy industry and in the old part of the town where houses were still heated by old-fashioned grates.

5.3. Another authority made the survey the occasion of a visit to all the steam-raising plants in their area and in this they have had the willing co-operation of the firms concerned. They have given a very comprehensive return showing the cause of heavy smoke production. In one instance opencast slack was being fed to an underfeed stoker, which promptly became choked. A low-pressure Lancashire boiler was being fired with rubber waste which could not otherwise be disposed of, while a locomotive type boiler fired with wood waste was the cause of heavy pollution.

5.4. It is gratifying to note that a number of local authorities are establishing air pollution stations with deposit gauges and sulphur recorders, in their areas.

One Authority has drawn up a special clause for inclusion in leases in connection with land under their control and used for industrial development, and laid down that all houses under their control shall be fitted with grates for smokeless fuel.

5.5. For these comprehensive reports and for many others prepared with great care and contributing much useful information, and for many supplementary reports that have been submitted, the Society offers its sincerest thanks to the local authorities responsible, and hopes that local authorities, whether they have contributed or not, and whether or not they are members of the Society, will be able to utilize the results of the survey in overcoming the atmospheric pollution in their own areas.

5.6. Having outlined the difficulties and drawbacks involved in the completion of the survey, the reservations that will have to be applied in interpreting the result will be apparent.

6. Smoke attributable to low-grade fuel

Where smoke is reported, its production is frequently attributed to inferior fuel. This applies to some 50 per cent. of the returns, and it occurs with such regularity that it requires careful consideration.

6.1. Some inspectors simply record the fact that the smoke produced is

stated to be due to inferior fuel, and were it generally true, the only conclusion that could be arrived at would be that all coal deliveries had been degraded.

6.2. When one remembers how easy it is, even with the best of fuel such as a dry Welsh steam coal, to produce large volumes of smoke by taking the appropriate measures, one is inclined to enquire whether the production of smoke in many instances is not due to causes other than poor quality of fuel. Some authorities record that plant has been converted to oil-firing but in some instances it is noted significantly that the conversion has not been accompanied by any reduction in the smoke emitted.

6.3. A number of inspectors are of the opinion that inferior fuel is not the sole cause of smoke and add that the boiler plant in question is obsolete and overloaded. In other instances, necessary renewal parts are stated to be unprocurable, while in others the inspectors have added that the substitution of hand for mechanical firing can be blamed. Frequently the inspector has come to the conclusion that the cause of smoke is bad firing, and in one instance it is stated that a visit of the Regional Engineer of the Ministry of Fuel and Power was instrumental in abolishing the smoke entirely.

6.4. In some instances the production of smoke is attributed to the inability to obtain the kind of fuel for which a mechanically fired plant was designed. One authority attributed most of the industrial smoke to pitch-fired boilers.

6.5. In another instance the inspector is of the opinion that variation in quality of fuel fed to mechanically fired plant was responsible for smoke production.

6.6. A steam-raising plant can be built and adjusted to consume smokelessly any kind of coal. In this connection, members of the Executive Council will recall the visit on April 27th to the laundry of the London Co-operative Society at Romford, Essex, where they saw a poor grade of heavily oxidized opencast coal of about 9,000 B.Th.U. per lb., being burned smokelessly in an economic boiler fitted with a coking stoker. If, however, a fairly constant quality of fuel—good or bad—cannot be relied on, it is difficult to see how waste of fuel and the formation of smoke is to be avoided, even with the best of mechanically fired plant.

6.7. One Sanitary Inspector very pertinently remarks that loss of standards due to war-time encouragement in the emission of smoke and now in many cases poorer fuel, is becoming a permanent excuse from both the management's and from the stoker's point of view.

The Chief Sanitary Inspector of one industrial area records that from his experience it is essential to employ a higher standard of fireman, encouraged by a higher scale of pay to study the technique of his work.

The Chief Sanitary Inspector of another authority has publicly announced that in his area records of fuel supplied to many plants in his area have been kept since before the war, and it is found in the majority of instances that grades in use to-day compare very favourably with those supplied in 1938.

A large Metropolitan Borough records a considered opinion that there is a tendency amongst combustion operators to lay all the blame on the fuel, whereas insufficient attention is being paid to the principles of complete and efficient combustion.

One authority records that although fuel is inferior, better supervision of firing has improved local conditions and that one firm attributes a saving of several hundreds of tons of coal to this cause.

One is led to the conclusion that the plea of inferior fuel is rather overdone and is likely to be used as an excuse for inefficiency for some time to come.

6.8. The value of stokers' training courses is frequently acknowledged. One authority says that the lack of training facilities for stokers had had adverse effect since the early days of the war while a neighbouring authority

says that a well-attended course for firemen is held at their technical college.

6.9. Some authorities complain of the difficulty of obtaining domestic appliances for burning smokeless fuel, while others refer to the difficulty in obtaining the smokeless fuel itself, and also of its high price. One Sanitary Inspector makes the rather surprising statement that domestic smoke is due mainly to prefabricated bungalows, which one understood were fitted with the most up-to-date smokeless fuel-burning appliances !

7. Service of the Ministry of Fuel and Power

The assistance that has been given by the engineers and stoker instructors of the Ministry of Fuel and Power is frequently fully acknowledged but the general tenor of reports made by many local authorities, leads to the conclusion that they might make fuller use of the technical services provided by the Ministry. The services of these officers is available free of charge to give advice at any time and the Ministry is ready on all occasions to offer its co-operation in advising on the control of plant, and in the training of firemen.

7.1. The Ministry, in conjunction with the City and Guilds of London, has arranged a series of courses at Technical Colleges throughout the country in the following subjects :

- (*a*) Boiler House Practice, Preliminary, Intermediate and Advanced grades.
- (*b*) Steam Utilization.
- (*c*) Fuel Technology.
- (*d*) Operation and Maintenance of Fuel Using Plant (Primarily for Works Engineers).
- (*e*) Operation and Maintenance of Mechanical Stokers.

The support of local authorities for these courses is invited. A list of some of these courses for the 1948-49 session is given in the August number of " Fuel Efficiency News," published by the Ministry, and full particulars can be obtained from the Secretary of the Local Fuel Efficiency Committee at the nearest Regional Office of the Ministry of Fuel and Power. Where there are sufficient applicants for a particular course of instruction, the Ministry is prepared to arrange for the requirements to be met.

7.2. Training schemes, however, will be of little avail without the support of employers who should be encouraged to appreciate that a properly trained fireman, capable of meeting the requirements of the works with a minimum fuel-consumption, and with no fuel sent up the chimney in the form of smoke and unconsumed gases, is a more valuable asset than a man capable only of shovelling coal on to a fire.

7.3. A fireman on passing his test might be given a certificate of a colour appropriate to the grade, signed by the Ministry and the City and Guilds of London, to fit into a small frame to hang in the boiler house. The certificate should entitle the fireman to a graded bonus that might be co-related to a bonus scheme such as that outlined in the Spring number of " Smokeless Air " for 1948.

8. Sources of Pollution

The sources of pollution recorded are many and varied.

8.1. *Collieries.* In colliery districts complaints arise in respect of steam-raising plant, burning spoil banks, and domestic smoke from the consumption of miners' coal. The first mentioned is probably occasioned by the use of low-grade unsaleable fuel, but it might be possible to modify the boilers so that the consumption of low-grade fuel would not necessarily be accompanied by volumes of smoke. Burning spoil banks are an old problem on which much remains yet to be done.

The smoke caused by the burning of the liberal issue of miners' coal is the source of a large number of complaints by local authorities, some of whom point out that the coal is wasted in old-fashioned grates kept burning day and night. It is probable that much greater service to the housewife in the way of space-heating, cooking, and hot water could be obtained by the consumption of a half or less of the

present issue of coal, were it consumed in an efficient type of stove or grate, and the formation of smoke would be thereby largely avoided.

8.2. *Railways*. Railways are frequently recorded as the source of atmospheric pollution—either from the engine sheds or round houses when firing-up or from shunting in marshalling yards. No ready remedy seems to be at hand in respect to the former, while trains continue to be drawn by steam locomotives, but some amelioration might be obtained in respect of the latter from the increasing use of Diesel shunting locomotives.

8.3. *Shipping*. Local authorities of Port areas complain frequently of the smoke from shipping, sometimes occasioned by deep-sea ships and at other times by river and harbour tugs. It looks as though much greater use might be made of the furnace door for providing a controlled supply of secondary air, devised during the war by the Fuel Research Station. One authority has recorded that during 1947 visits were made on account of smoke, to seven vessels, all oil burners. A slight adjustment of oil feed and burner valves was all that was required to avoid the nuisance.

8.4. *Power Stations*. Complaints are recorded frequently—in some 80 instances—of sulphur and grit from power stations. With the establishment of a growing number of large modern power stations, the problem of emission of oxides of sulphur and grit will be of increasing magnitude and difficulty, the solution of which, whatever form it takes, is likely to add to the cost of electricity. Since, however, electricity has become almost the universal source of power and the source of much smokeless heat in the modern world, increased cost may have to be faced.

8.5. *Metallurgical Processes*. Blast furnaces, cupolas, and other metallurgical processes appear frequently as responsible for much atmospheric pollution.

8.6. *Coke Ovens and Gas Works*. Coke ovens and gas works are frequently the cause of complaint, generally in respect of dispersion of grit. In the case of gas works, it arises usually from horizontal retort houses and the blast from water gas plant in respect of which there seems to be no remedy. There are, however, several complaints of steam-raising plant at gas works.

One local authority reports that the chief discomfort arises from the grit from a battery of coke ovens. The authority has been pressed to erect a number of aluminium bungalows in close proximity to the coke ovens and it is impossible for windows ever to be opened on account of heavy deposit of grit. An extension of the battery is in progress when the nuisance will probably be worse.

8.7 *Laundries*. In more than 150 instances, the laundry is the cause of much atmospheric pollution. In fact a large section of the industry seems to be engaged at a considerable cost to themselves in dispersing soot that they are prepared, at a price, to remove from our fabrics.

One county borough reports that it has five laundries all of which are responsible for heavy smoke, while another seaside town records three laundries all emitting heavy smoke.

One local authority, in reply to the question on the form relating to Part I of the Survey as to whether conditions were better or worse than in 1939, replied that they were much better, and gave as a reason the fact that the local laundry had been burnt down. Many authorities reported their only source of smoke as domestic chimneys and the laundry. Sanitary Inspectors frequently report that the steam-raising plant is old and overloaded, and that replacement parts are not obtainable. While not suggesting that the drastic remedy above referred to should be applied universally, it may be that something might be done to enable laundries to raise steam without defiling the atmosphere. The one at Romford already referred to is an outstanding example.

8.8. *Clay Industries*. Brickworks, tileries and potteries appear with regularity as defilers of the atmosphere. Some of the more highly developed potteries and tileries, it is well known,

are in course of turning over to smokeless tunnel ovens, but it is a question whether something could not be done to improve the performance of the local brick and sanitary pottery works.

8.9. In addition to the sources of pollution mentioned above, there frequently occur as offenders breweries, textile and paper mills in respect of their steam-raising plant, chemical works from fumes and also steam-raising, and dyeworks where large volumes of low-pressure steam are required at intervals. There are many complaints of obsolete, worn out and overloaded plant and it is recorded in several instances that new plant or replacements are on order but cannot be obtained. In one case it is recorded that a plant designed to burn coke has had to burn raw coal owing to coke being unobtainable. Dust from cement works is a frequent source of complaint. In one district a committee of representatives of local authorities has the matter under consideration. One authority records the collection of dust from a quarry in ducts but of the final disposal of the dust by blowing it into the air, when it is distributed over dwelling houses. Government establishments such as Royal Ordnance Factories are frequently mentioned as responsible for atmospheric pollution. A town in Scotland reports that the purifiers at its gas works are inadequate to deal with the increased output.

9. There are also frequent complaints about public institutions such as baths, hospitals, etc., which would seem to be within the control of local authorities themselves. Again another municipal plant that seems responsible for much smoke is the refuse destructor. It is said in some instances to be due to attempts to burn wet refuse, which of course is likely to give trouble.

9.1. On top of this is the all-pervading domestic smoke and the steam-raising plant associated with small local industries. Very often the latter are fired with wood or other refuse, which makes a readily available source of heat and which is capable of being burned smokelessly in proper plant, but when fed irregularly on to the fire in small locomotive type or vertical boiler, is likely to be the source of great annoyance to the neighbourhood.

9.2. One or two authorities exhibit some anxiety as to the effect of the establishment of the projected satellite towns in their areas.

10. Outlook of Local Authorities

The Survey has disclosed the great difference in outlook that exists on the problem of the pollution of the atmosphere. In some quarters mankind seems to have become so accustomed to living in a smoke-laden atmosphere as to be unconscious of his environment.

10.1. In their response to the Society's questionnaire, local authorities display very different outlooks. There are those intensely conscious of the problem, anxious to take systematic measures to ascertain the intensity of pollution and ready to take all measures within their powers to improve the conditions of their area. They frequently give evidence of a sense of frustration in the lack of interest of owners of fuel-burning plant, and of the employees operating it, and in the lack of support from higher authority. They have generally gone out of their way to give the Society all available information, and for the helpful attitude they have adopted the Society expresses its gratitude.

10.2 Other authorities have shown a limited interest, sufficient to cause them to become associated with the movement to obtain a cleaner atmosphere and to obtain such information on the subject as may become available. The Society is grateful for their support and their help, and ventures to express the hope that their interest will increase and that they will yet take a more active part in the campaign. Quite a large proportion of those addressed disclose a complete lack of interest : some have indicated their lack of interest, while others have ignored altogether the Society's questionnaire. It is hoped that their interest in this important problem will be awakened and that they will ultimately take their places in the

campaign for the prevention of smoke, which not only defiles our land, but is the visible indication of the wasteful use of our vanishing supplies of fuel.

10.3 Many local authorities record drift of pollution from other areas, and in highly developed areas such as Lancashire, Yorkshire and London, this is inevitable. This factor gives some force to the suggestion that has been put forward that joint local committees should be established in all areas.

10.4. It is worthy of note that although atmospheric pollution is the responsibility of the Local Authority's Medical Officer of Health and the Sanitary Inspector, the returns in many instances bore only the name of the Town Clerk or Clerk to the Council. This applies to about one-third of the returns reporting no atmospheric pollution.

11. Conclusion

The preceding summary, subject to such reservations as may have to be made on account of the incompleteness of the return and for the reasons already mentioned, gives a brief outline of the commonest causes of atmospheric pollution. It accounts for some fraction of the millions of tons of smoke, soot and associated unconsumed gases that we continue to put into the atmosphere each year, and as a result are compelled to spend considerable sums in cleaning and repairing stonework, replacing corroded metal work, renewing paint, washing fabrics and so on.

11.1. Has the Survey been worth while ? This question can be answered very definitely in the affirmative. It has shown first of all that the principal sources of pollution fall into separate categories :

There are those associated with industries such as coal-carbonization, metallurgical processes, power stations, etc., where the smoke, sulphur and grit problem is not capable of a ready complete solution and where research and experiment on a considerable scale is still necessary.

In these and in other instances, partial solutions would seem to be available. There seems to be no reason why steam-raising plant at colleries should not be operated in a manner to give less offence although a good deal of work appears to be necessary on spoil banks. The gradual substitution of Diesel shunting locomotives should improve the conditions in marshalling yards, but while the steam locomotive is the chief source of railway traction, engine sheds are likely to be the source of atmospheric pollution. The increasing use of water-tube boilers in new ships and improved control of combustion should contribute to some improvement in conditions of which local authorities in port areas complain, while in other instances a remedy is to hand, in the furnace door produced during the war by the Fuel Research Station, the use of which should be encouraged.

On the other hand, many other sources of pollution should be capable of being remedied by means already to hand. The steam-raising plant of textile mills, breweries, laundries, and other industries should be capable of more efficient operation to the financial advantage of their owners, by some improvement in the technique of firing, and by some modification of plant as and when circumstances permit. There is a general consensus of opinion among officers of local authorities that stoking leaves much to be desired. A remedy might be found in the adoption of a scheme recommended by some of them, in which firemen, or at least the younger of them, should be examined and on certification promoted to a higher scale of pay. Some of the courses already available for training firemen have been referred to briefly in paragraph 7 of this report.

12. With regard to domestic smoke that forms such a high percentage of the general atmospheric pollution, it is anticipated that by the time this report is presented the production of stoves and open grates for burning smokeless fuel will meet the requirements for all new houses. There would then be no reason why housing authorities should not install such appliances in all new housing schemes. Could we hope that the Ministry of Health and the Depart-

ment of Health for Scotland would consider the advisibility of instructing local authorities to insist on the installation of stoves or grates for smokeless fuel in all new houses whether publicly or privately built. Even where smokeless fuel is not immediately available, these grates will burn bituminous coal more efficiently, and consequently produce less smoke that the older types of grates, until such time as smokeless fuels are available in sufficient quantities, and it is to be hoped, at lower prices than at present.

12.1. As the production of smokeless appliances increases, it should be possible to evolve a policy to encourage the replacement of grates of older types by those for burning smokeless fuel, or in blocks of flats and tenements by efficient central heating systems.

13. The Society's efforts to carry out this national survey of atmospheric pollution, the results of which have been outlined above, have made it clear that an authoritative survey will be possible only if undertaken under Government authority by the Departments directly concerned, with systematic observations and measurements. Such a survey is a matter of some magnitude, and before that can be launched there is much that has been disclosed by the Survey that can be undertaken to prevent a very considerable part of the pollution of the atmosphere of the country.

14. This very brief interim report is based mainly on the report in general terms given on Part I of the survey, reinforced by reference to the detail on Part II. The analysis of Part II will be a matter of some magnitude on whatever basis it is undertaken. This will be carried out in due course: but meanwhile many members of the Conference may have views as to how the analysis should proceed.

PROGRESS REPORTS

Introductory Review

By ARNOLD MARSH, *General Secretary*

THE reports we are to discuss this afternoon constitute a new feature of these conferences. If the session is successful, which I think it will be because of the encouraging nature and wide range of information contained in the reports, then I hope it will be decided to have similar sessions at all future conferences. The reports are, of course, only a selection of the many that could have been invited, and it may well be that other topics should have been included. Another time the pattern may be quite different.

We have called them, with no great originality, simply "Progress Reports," but it will be noted that none of them actually record the ultimate progress that is the only real measure of the success of this work of ours—none of them, that is, record any observable improvement in the state of the atmosphere. They are all records, in one form or another, of preparatory steps taken either to prevent a worsening of conditions or to improve conditions in the future.

This in no way detracts from their value, for such work is the essential foundation of the positive progress we seek. Nevertheless, I must confess to a burning ambition to be able to comment on the kind of report we have recently been receiving from Pittsburgh and other cities in North America. At bottom, no doubt, this is simply a feeling of envy, and for a moment I should like to try to infect you all with the germs of that most useful stimulus.

Perhaps therefore I may apparently digress by first looking at Pittsburgh, and from there work back to our own reports.

In his Presidential Address at Edinburgh last year, Sir George Elliston mentioned that on the same day, 1st October, Pittsburgh's new smoke prevention ordinance came into force. To-day, then, it has been working for exactly one year. In effect, it seeks to turn the whole of the city into a smokeless zone, by means very similar to those towards which we are gradually moving. The ordinance regulates both the fuel that is used and the plant in which it is burned. The use of high volatile bituminous coal—the source of most of the smoke—is forbidden in all but mechanically-fired furnaces. In all other appliances only coal with a volatile content of less than 20 per cent. may be used. This applies to domestic as well as to industrial installations.

Not only is the prior approval of new and reconstructed installations required, but equipment other than domestic is subject to an annual inspection and the issue of a certificate of operation. Locomotives must use solid smokeless fuel or be equipped with mechanical firing. Penalties are of course maintained for emissions of smoke, grit or fumes that exceed defined limits.

It was not too easy to apply and enforce the new regulations during this first year, thanks to unusually severe winter weather and a consequent scarcity of solid fuel, but they have come through the test with flying colours. Pittsburgh does not yet claim, of course, to be free from smoke, and it suffers from the heavy pollution of the great steel manufacturing plants and other industry outside the city limits.

Nevertheless, their progress report is that during the past winter they enjoyed 39 per cent. more sunlight than during the previous winter. Comparison between two single years is not of course a conclusive proof of improvement, but in this case it is claimed that weather conditions were such that without any change in smoke output there would have been less sunshine than during the previous year. An important article on Pittsburgh's campaign, by Mr. Arnold Reif, a member of the Society at present engaged in research work in that city, will be published in the next issue of *Smokeless Air*.

To ourselves, the moral of this, and of other experience in the U.S.A. and elsewhere, is that the policies the Society has been advocating and discussing—smokeless zones, control of the sale and use of coal, prior approval of installations, and so on—are workable, reasonable, and successful. It is not suggested that we should imitate American practice in all respects, and in particular I think it will be agreed that we do not want individual cities to go so far ahead on their own that they would absorb more than their fair share of smokeless fuels and new appliances. The alternative to such unilateral action is to plan progress in stages in the cities and areas where such action is most necessary: in other words, by the establishment of expanding smokeless zones.

From this glance at the final target we can come back to look at the first of the reports that are the real subject of these comments: the smokeless zone clause of the Coventry Corporation Act. This is of particular interest, for although similar clauses in other local Acts have been agreed to largely in default of any opposition, circumstances in Coventry led to an actual ballot, for or against, among the citizens. The substantial majority in favour of a smokeless zone is a most encouraging endorsement of our belief that the measures we propose will, when once they are fully explained and understood, be supported by the people—whether they are in Pittsburgh or in Coventry.

Reference is also made in this report to the clauses of the Coventry Act that require new fuel-burning installations to receive prior approval: a principle that is an essential part of all modern smoke prevention legislation, as we can see not only in Pittsburgh but in a hundred other American and Canadian (and even Indian) cities.

The fears that have been expressed from time to time that prior approval would not work, or that it could not be worked even by properly qualified local authority officers, are shown to be

groundless by the reports on such schemes in Leeds, Sheffield, and Birmingham. In each case the administration of the scheme has obviously been reasonable, understanding, and constructive. This pioneer work is a valuable guide to other authorities and helps to clarify the principles and practice we wish to see in the national legislation that is to come.

Here, I think, we may claim really tangible progress, not in reducing existing pollution, but in preventing new. The modifications to plant that have been secured must in many cases have done much to ensure both better fuel efficiency and less smoke than would otherwise have been the case, but beyond this there are benefits that are likely to have accrued unseen through the mere existence of the control. The knowledge that plans will be vetted must in itself raise standards and ensure more foresight and care.

Unfortunately received too late for inclusion in the advance printed papers, is a report from the City of Salford, which has also recently obtained a new Act. One or two paragraphs in this report are of such importance that I propose to quote them in full.*

Progress of another kind is indicated in the reports about the Carrington Power Station and from Thames-side. Here we see local authorities getting together to solve their common problems. In the one case it is an essential step in the prevention of a possibly serious source of new emission ; in the other it is a joint attack on a problem of many years' standing.

The important feature of the Walsall report is the same as that in the one about Carrington—namely, the keeping of atmospheric pollution records in an area where new development is taking place, so that conditions before and afterwards can be statistically compared. In this connection it may be of interest to note that observations are being made by the D.S.I.R. in the Stevenage district, so that as the new town comes into being it will be possible to see the deterioration—or, as we hope, absence of deterioration, in the state of the atmosphere. Such work is of great importance and is commended to all local authorities with similar development schemes in prospect.

A different type of local authority co-operation is that recorded from Bristol. Here we have an excellent example of joint action in smoke prevention between the different departments of the one local authority. How many opportunities, one wonders, are lost by a lack of an early pooling of ideas and exchange of information about projects, and a conscious effort towards full co-ordination. This is perhaps something that most directly concerns the larger authorities, and the scheme should be noted particularly by their representatives here to-day.

From the Fuel Research Station comes a report of progress in the task of abolishing domestic smoke—the foundation work of testing the new appliances that among other things will make possible the general use of smokeless fuels. This is a kind of progress report that the public will hardly note or appreciate, but which must be done before we can advance towards our objective of smokeless homes.

More immediate in the progress it will provide is the furnace door described in the other Fuel Research Station report. This simple invention —and successful perhaps because of its simplicity—was first applied to prevent tell-tale smoke from merchant ships in danger from U-boats. Thus an invention to save life in war is being used to safeguard health in peace.

The final report, on central and district heating schemes, is another important example of progress being made to prevent new smoke coming into being. District heating should be welcomed and encouraged by the smoke abatement movement, although the case for it has perhaps been endangered at times by over-enthusiastic claims. The proof of the pudding must of course continue to be the traditional one, and it is excellent that there should be so many schemes now in train, which should clearly demonstrate the extent of the field over which district

* See page 37

heating can and should be applied. It seems certain that it will be large enough to make a really substantial contribution to our cause.

Since time has allowed only a brief mention of each of the reports, it has seemed necessary to look only for the most significant point in each. And thus, although from none of them can we extract anything like that remarkable 39 per cent. increase in sunlight that is the news from Pittsburgh, each one, in its own way, shows some tangible and essential step forward. If we will but persevere and redouble our efforts I have no fear that we shall, before very long, have reports of more sunlight, diminishing soot deposits, bigger fuel savings, and public gratitude, flowing in from all parts of the Kingdom.

The Coventry Corporation Bill

1. Following the conference of the National Smoke Abatement Society held at Brighton in October 1946, a fellow delegate and myself submitted a report of the Conference proceedings to the Health Committee embodying in the report certain recommendations with a view to the prevention of smoke emission from industrial sources. In addition I wrote to the Town Clerk stating that the time was now opportune, in view of the proposed reconstruction of the City Centre, to take steps to prevent as far as possible, atmospheric pollution by the emission of smoke from industrial and domestic buildings and suggesting that in the event of any new legislation being contemplated locally, appropriate provisions for the prevention of smoke emission into the atmosphere should be introduced.

2. In November 1947, a private bill was drafted primarily to empower the City Council to construct waterworks and take further water from the river Avon. Clauses were drafted in the bill to secure other powers to deal with nuisances, sanitary matters, etc., including the prohibition of smoke in certain areas, i.e. to establish smokeless zones ; also to prevent the emission of smoke from industrial furnaces, by prohibiting the installation of furnaces for industrial purposes which are not so far as practicable capable of being operated continuously without emitting smoke.

In addition clauses were included to empower the Council to establish works for the provision of heat and hot water, i.e. to introduce a system of "District Heating."

3. Many difficulties and much prejudice had to be overcome before the bill reached the Committee stage.

Owing to the inclusion in the bill of certain clauses relating to the provision of a municipal taxi service, provision of hotels and other trading clauses, an electors' meeting was held and each clause was voted upon. At this meeting the clauses relating to "District Heating" and "Smokeless Zone" were opposed and lost. Fortunately, however, in view of the large number of citizens who were unable to gain access to the hall on the night of the meeting, the Council decided that the fate of the opposed clauses should be decided by ballot. A ballot was held and the results of the voting of the citizens in so far as "District Heating" and "Smokeless Zones" were concerned were as follows :

	For	*Against*	*Majority*
District Heating	26,934	12,555	14,379
Smokeless Zone	27,990	11,302	16,688

(The total number of votes was 40,775, equivalent to 23 per cent. of the total electorate (180,000).)

4. **Smokeless Zones**

As is well known Coventry suffered

extensive damage by aerial bombardment during the recent world war and the central area comprising the shopping centre, was completely demolished. Plans have been prepared for the reconstruction of this central area which will form the centre of the " Smokeless Zone " comprising a district of approximately 30 acres.

5. In order to ascertain the number and nature of fuel burning appliances in the buildings included in the area a survey was undertaken. Each building was visited and particulars obtained of types of burning installations in use and the quantities and nature of fuel consumed.

6. The survey indicated that the majority of premises relied upon gas and electricity for heating ; in only one instance, in a restaurant, was solid fuel used for cooking and in this case there were several stoves, all except one being heated by gas. It was apparent that the creation of a smokeless zone in the area would be a practical proposition and unless the opportunity was taken to seek the necessary powers the injurious effects upon the health of the community and the deleterious effects upon the new buildings to arise from the ruins of the old, would continue.

7. Some opposition was forthcoming from certain sections of the electorate with regard to a smokeless zone on the ground that the clause did not make provision for the payment of compensation to meet cost of installing new grates or furnaces in every case, the clause reads as follows :

> " The Corporation *may* if they think fit contribute to the whole or part of this expense necessarily incurred in executing works for the purpose of complying with the clause."

This opposition was, however, withdrawn before the bill reached the Committee stage and the entire clause has since been allowed.

8. The powers in the bill can be applied to any area or areas in the City which may be prescribed by order made by the Council and confirmed by the Ministry of Health.

Thus an opportunity arises and as the public become more smoke conscious and old prejudices are overcome, the zone can gradually be extended.

Prevention of Smoke from Industrial Furnaces

9. This clause gives power to prohibit the installation in any building of any furnace for steam raising or for any manufacturing or trade purpose, unless such furnace is so far as practicable capable of being operated continuously without emitting smoke.

10. If the person before installing in a building a furnace, submits plans and particulars of the installation, the Corporation shall within six weeks serve a notice upon the person stating whether or not they are satisfied that the proposed furnace is so far as practicable capable of being operated continuously without emitting smoke. If they are so satisfied or if they do not serve a notice upon the person as required, no proceedings can be taken against the person under this section. A person who installs a furnace and who does not give notice to the Corporation can be proceeded against in the event of the installation emitting smoke and is liable to a penalty not exceeding £10 and a daily penalty not exceeding two pounds.

11. The Ministry of Health submitted reports in Committee commenting upon this clause to the effect that " He does not think this clause adds anything useful to the provisions of the general law regarding pollution of the atmosphere, which is the only aspect of the matter with which he is concerned."

(2) " He considered that it would be difficult for the Corporation to decide at the " Plans " stage whether the installation of the furnace would contravene sub-section (1) of the clause, i.e. the sub-section which prohibits the installation of any furnace unless it is as far as practicable capable of being operated continuously without emitting smoke."

12. With regard to objection (1) it was pointed out that the object of the clause was to ensure that all new furnaces

installed are from the start as far as practicable capable of being operated continuously without emitting smoke, i.e. that the best known type of furnace available at the time of installation is used, and thus prevent a nuisance arising, rather than allowing the nuisance to arise and then attempting to cure it.

13. With respect to query (2) it was explained that this could be decided by any qualified and experienced Smoke Inspector and that it was already his duty to decide on types of installations, when dealing with smoke nuisances.

Following these explanations in Committee the Ministry of Health raised no further objection and after the members of the Committee were reminded that very similar provisions had been given in the Preston Bill recently before Parliament both clauses were allowed.

14. In conclusion it is significant from the proceedings that with respect to the establishment of a "Smokeless Zone" in existing industrial areas the cost involved in new installations appears to be the primary factor, and secondly that in regard to the "prior approval" clause, evidence must be forthcoming that a local authority has qualified Smoke Inspectors who are experienced to judge at the "Plans" stage whether a particular type of furnace or installation will operate satisfactorily.—*W. Beaumont, Chief Sanitary Inspector, City of Coventry.*

Carrington Power Station

A JOINT Committee representative of the Borough Council of Stretford and the Urban District Council of Urmston in South East Lancashire, and the Borough Council of Sale and other more distant Local Authorities in North East Cheshire, have met with a substantial measure of success in impressing upon the Electricity Commission the need for precautions to be taken against pollution of the atmosphere by discharges from the 330 foot chimney of the new power station that is to be built at Carrington. At the outset directions were given by the Commission to ensure that this generating station, which is to have an ultimate capacity of 400,000 kilowatts, shall incorporate electrostatic precipitators designed to arrest smoke and grit.

In regard to the emission of sulphur and its compounds into the atmosphere, whilst the Commission declined to order the installation of gas washing plant as an integral part of the station from its beginning, they directed provision to be made for such installation at a later date and, as appears below, there is a prospect that consideration will be given to the desirability of ordering the installation of suitable plant on evidence being adduced by the Local Authorities to show that sulphurous emissions are in fact causing measurable pollution.

The Local Authorities, after taking the advice of the Department of Scientific and Industrial Research, have resolved to set up measuring instruments in various parts of the area by which it will be possible to establish scientifically the incidence of atmospheric pollution before and after the power station is put into operation.

At an interview in London between a deputation from the Joint Committee and the Chairman and other representatives of the Commission, it was pointed out on behalf of the Commission that gas washing had only so far been directed at two stations, i.e., Battersea and Fulham. The Battersea system, it was stated was only possible where almost unlimited quantities of water were available. At Fulham, the required amount of water not being available, another system, known as the "closed system," had to be adopted. Under both systems an elimination of about 95 per cent. of the sulphur in the flue gases was achieved.

The deputation were informed that the Battersea system could not be operated at the Carrington Station and

that the Commissioners felt they would not be justified in directing the adoption of the Fulham system, which in certain respects had proved to be unsatisfactory. Certain experiments were now, however, being conducted and the Chairman of the Commission stated that, whilst he could not, at the time of the interview (January, 1948) commit the Ministry of Fuel and Power, who would be responsible after the dissolution of the Commission, he felt sure that the Ministry would give sympathetic consideration to any representations by the Local Authorities and that the Minister would have regard to the readings of the test instruments which the Local Authorities were to install under the guidance of the D.S.I.R. in support of such representations.

This intimation was distinctly more satisfying than the Commission's previous communication to the effect that the adoption of gas washing would not be directed except on evidence that the discharge of sulphur and its compounds into the atmosphere was having a "harmful effect." It might have been difficult to prove that sulphurous emissions were literally causing damage to plant life or to materials, or injuring human health. The Local Authorities had submitted throughout the negotiations that if, as the result of the operation of the station, there was a measurable increase in atmospheric pollution, then that in itself would be justification for the adoption of gas washing. It is to be noted that, whilst the Commission have not gone all the way with the Local Authorities in this, there is reason to believe that the measuring instrument readings will be accepted by the appropriate Authority as evidence to be carefully weighed.

As to the measuring instruments to be set up by the Local Authorities as mentioned above, these are to be 28 in number and in the main are to be sited at points one mile apart with some at two mile intervals. Some of them will be situate to the south and west of the power station but the majority will be in the path of the prevailing south-westerly winds by which the chimney emissions will be borne. As plotted on a map the stations are shown roughly as at the intersections of vertical and horizontal lines describing one mile squares. There are to be six combined stations comprising lead peroxide apparatus with deposit gauges (at Ashton-upon-Mersey; Warburton; north of Carrington village; Irlam; between Flixton and Urmston; and near Broadheath, Altrincham). Sixteen lead peroxide stations are to be distributed between Stretford, Sale, Altrincham, Ashton-upon-Mersey, Urmston, Davyhulme (2), Sinderland, Carrington, Flixton, Partington (2), Irlam and beyond (4).

The supply of apparatus, arrangements for analysis, submission of returns to the Department of Scientific and Industrial Research, and reports to the Local Authorities are matters which the Manchester and District Smoke Abatement Committee have in hand, the Committee having agreed to act as agents for the Local Authorities and where necessary to collaborate with the Manchester Corporation Electricity Department. The Committee will, of course, be reimbursed by the Local Authorities in respect of the cost of analysis and other incidental expenses. These costs are to be borne as to a quarter each by Stretford, Urmston and Sale and as to the remaining quarter by the other Local Authorities situate more distantly from the power station.—*L. Watkins, Clerk of the Council, Urmston District Council.*

Developments in Walsall

Recording Pollution

FOR many years, in co-operation with the Department of Scientific and Industrial Research, one atmospheric pollution gauge was operated. In 1946, the Council decided that in order to maintain a closer check on the general level of atmospheric pollution

throughout the Borough, four additional deposit gauges be installed on sites approved by the D.S.I.R.

When it was known that a new power station was proposed to be built in the Borough, arrangements were made to have lead peroxide gauges installed, and in July 1947, five gauges were placed at the same stations as the deposit gauges. Two additional lead peroxide gauges have been operating since April this year, so there are now five deposit gauges and seven lead peroxide gauges. While siting of the gauges is not an easy matter, it is hoped to establish a further five lead peroxide gauges at an early date. Analysis of the deposits by the Chemist at the Corporation Sewage Works, provide evidence of the degree of contamination in industrial and residential areas of the town. Records of pollution are published quarterly in Council Reports, and it is found that such publication is extremely useful in that it focuses attention on atmospheric conditions and encourages discussion as to amelioration of pollution. In the Council and local press there is evidence of a growing "smoke" consciousness which is encouraging.

Positive Action

The Council have appointed a specialist sanitary inspector to undertake smoke abatement work.

Attention is being directed to persistent offenders, and in such cases a series of tests are arranged over a continuous period of five or six hours when loads are heaviest. The quantity and nature of fuel fired, the methods and frequency of firing, and readings of control instruments are recorded on specially prepared charts.

A Cambridge CO_2 and flue gas temperature indicator has been purchased for the use of the department.

Simultaneously, a graph showing variations in smoke density throughout the period of the test is prepared.

Comparison of the two charts provides valuable information as to the causes of the smoke emissions and indicates possible remedies. This method has been helpful, and has been appreciated by the managers of the offending undertakings. Unfortunately, these tests make heavy demands on the Department's technical staff, and in consequence have only been used on a limited number of occasions.

The helpful advice of the Regional Officers of the Ministry of Fuel and Power is readily available in all cases of difficulty.

Local Authorities' own boiler installations are being given special attention and it is hoped that these will soon give no further cause for complaint.

Publicity

Endeavours are being made to educate the public on the problem of atmospheric pollution in the town, and to indicate to them the broad lines along which a solution lies.

Examples of efforts in these directions are :-

(*a*) Talks to Youth Movements, Clubs, Religious Organizations and Womens' Guilds.

(*b*) Circularising of occupiers of factories and commercial buildings in connection with the recent Survey of the Sources and Incidence of Atmospheric Pollution. Such occupiers have been invited to make suggestions for reducing atmospheric pollution and to discuss their own problems with the Department's Officers.

Legal Powers

Although Walsall has at present no legal power requiring users of fuel-burning plants to obtain prior approval of the local authority, an inter-departmental arrangement has been made for copies of plans of factory and commercial buildings to be submitted to the Chief Sanitary Inspector for his comments. Where it is proposed to install new plant of a type likely to cause nuisance, a report to this effect is made through the Borough Surveyor to the Public Works and Town Planning Committees. In such cases informal efforts are made to secure modification of the proposed plant so as to eliminate or reduce smoke nuisance. Where applicable, use is made of the provisions

of the Town and Country Planning Acts to control the establishment of trades likely to cause smoke or other nuisance.

Every endeavour is made to secure the co-operation of factory managements in the work of smoke abatement. The Department's policy is to resort to legal sanctions, only in the case of persistent and unco-operative offenders. —*C. A. Stansbury, Chief Sanitary Inspector, County Borough of Walsall.*

Prior Approval in Birmingham

WHEN the Public Health (Smoke Abatement) Act, 1926, was repealed and re-enacted by the appropriate sections of the Public Health Act, 1936, it became apparent that from a legal point of view no great change had been made towards the elimination of smoke nuisances. Therefore, when the 1936 legislation came under review, the Medical Officer of Health, having regard to the excellent results already obtained by the advisory work done by competent and qualified inspectors, recommended to the Health Committee that this work should continue, and could usefully be employed in implementing Section 101, paragraph (*a*) and (*b*), which deals with installations and chimneys, and Section 103, sub-section 3, which defines "best practicable means."

The extension of this advisory work was based on the logical conclusion that endeavouring to ensure good combustion conditions in the firegrate of new installations was as equally important as dealing with the installation or chimney as a statutory nuisance should that event arise.

The co-operation of the City Surveyor was readily obtained with the result that arrangements whereby all plans submitted to the Local Authority for approval under the building by-laws, and which relate to industrial chimneys, boiler houses and industrial buildings showing boiler and furnace space are passed to the Public Health Department for comment.

By this arrangement it is possible for those engaged on smoke prevention to approach the owners or architects, who deposit the plans, and to discuss with them the type of plant proposed to be used, and the necessity of providing the best practicable means for preventing the creation and emission of smoke or grit, so eliminating as far as possible in this early stage the likelihood of any nuisance arising.

To avoid delay in the approval of these plans this informal advisory work entails prompt attention and tactful approach, but in most cases it has been proved that any suggestions put forward or any advice tendered has been in the main accepted by the owners or the architects. The plans are then returned to the City Surveyor with any necessary comments for consideration by the appropriate Committee.

By this means 248 plans have been brought to the notice of the Public Health Department and have included all types of steam raising boilers, incinerators, gas producers, sectional heating apparatus, bakery ovens, drying ovens, re-heating, melting and enamelling furnaces, together with numerous iron and brick chimney stacks.

The fuels used vary, with the majority being coal fired with natural or forced draught conditions—about 12 per cent. utilize mechanical stokers ; 6 per cent. use oil fuel and 2 per cent. pulverized fuel, with isolated cases burning trade process refuse.

No adverse comment was necessary in 125 cases of the remainder ; such matters as the provision of grit arrestors, use of mechanical stokers, provision of dampers, use of coal on small vertical boilers, advantages of economizers, use of instruments, pre-heating arrangements for oil and creosote pitch fuel and insufficient height of chimney stacks, were matters which the Department found necessary to draw to the attention of the depositors of the plans. In the majority of these cases sugges-

tions made during discussions are generally appreciated and acted upon. This is especially noticeable when dealing with the Architects—no doubt because they appreciate discussion at an early stage on new developments and also their desire to contribute towards general amenities.

The question whether prior approval of new fuel burning installations by the local authority or other competent body should be obligatory or not remains for future national legislation but it can be stated that the advisory work as carried out in this informal manner especially in the early stage can be most valuable and in practice quite successful and a contribution towards smoke abatement.—*G. W. Farquharson, Senior Smoke and Factories Inspector, City of Birmingham.*

Prior Approval in Sheffield and District

IN the larger cities of Great Britain, there is nothing new about the "Prior Approval" of heating apparatus, which has been carried out for years, but has now become intensified owing to the advancements made under the Town and Country Planning Acts, 1932 and 1944, together with Leasing Clauses which have been added to certain Corporation by-laws.

In March, 1946, a clause was inserted in the Sheffield Corporation Leasing of Land which stated:

> "All fuel burning apparatus shall be of a type to be approved by the Corporation and shall be such as is adopted for the burning of smokeless fuel, or shall be so constructed as to consume or burn any smoke arising therefrom and the lessee shall, before installation, of such apparatus, obtain due approval of the Corporation to the specification thereof."

Shortly after the insertion of this clause, it was found that adjoining Corporation property, which was to be re-developed, was not subject to any restrictions and this was reacting to the disadvantage of Corporation land, particularly in the central and residential areas; so it was resolved to ask for similar conditions under the Amenity Clauses of the Town and Country Planning Acts of 1932 and 1944. Since that time, over 600 plans of new and reconstructed premises have been supervized and advice and assistance given with regard to fuel burning apparatus.

Having due regard to fuel shortage, also to the difficulty of heating engineers to choose the type of fuel to be burned and the type of apparatus to be installed, this task of mutual decision has not been an easy one and there have been times when it appeared impossible to obtain a reasonable standard of smokeless conditions in the residential and central areas.

Tribute must be paid to manufacturers and architects alike, who have appreciated what was being attempted and have at times altered their heating plans completely, in order to add their quota to the scheme of smoke prevention.

There have been individuals who looked upon this scheme as "Unwarrantable interference" which was "curtailing the right of the individual to use the type of apparatus and fuel he wanted to," having little regard for his neighbour or amenity.

There have been only seven appeals to the Planning Committee against the decision of the Officers and these have in every case been amicably settled, though in certain cases, provisional relaxation of "Standards" has had to be agreed upon.

It has been stated that over 600 plans have been approved, but it should be added that each year over 2,000 plans of new and altered premises have been dealt with by the Plans Sub-Committee, the majority of them not having any heating apparatus to consider.

Arising out of this arrangement of

"prior approval," there are certain features to which attention can be given.

(*a*) In the central and residential areas, gas or electrical heating has been asked for, though in certain cases, oil-fired central heating has been agreed upon as an alternative.

(*b*) Coal-fired apparatus with mechanical stoking has not been approved of as being entirely smokeless, but has been freely installed in the Light Industrial Areas and in the Heavy Industrial Area. A minimum height for a chimney has been kept at forty feet, but the contours in Sheffield make uniformity of height difficult.

(*c*) Coke-fired central heating boilers and slow combustion stoves have not been looked upon with favour, for it has been proved that where hand firing is in operation, coal, wood and industrial refuse have been used on many occasions and caused considerable nuisance. This was particularly prevalent during the crisis period in 1947, but has continued since, when there was no necessity for it. In practice, it is found that a coal fired heating plant with a mechanical stoker, is preferable to a hand fired coke boiler, as it is not so easy to dispose of undesirable trade refuse in this type of apparatus.

(*d*) The need for reliable certificated stokers who have a technical knowledge of combustion appliances has been fully emphasized since these new conditions of prior approval have been put into operation.

In conclusion, it can be stated that progress has been made, though it is much too early to appreciate the far-reaching effects of the work that has been accomplished. The amount of time and consideration necessary to ensure good combustion conditions is considerable and minor errors have been made with regard to the types of appliances being installed. There are good and bad types of mechanical stokers, as well as stokers that are only adapted for "light duty" working, which are of little use to manufacturers with heavy fluctuating loads. The experience of the past two years has been well worth while and it is hoped that further progress can be made and will show the desired results in the next ten years. —*James Law, Chief Smoke Inspector, Sheffield, Rotherham and District Smoke Abatement Committee.*

Prior Approval in Leeds

DURING the past 2½ years, 82 proposals for alterations to existing furnaces or chimneys, or the construction of new boiler plants, were submitted to the Corporation for approval. Of these, 41 were approved without comment and 41 were approved subject to various modifications.

31 of the 41 schemes approved without comment were designed to use some form of smokeless fuel, but for various reasons, two have since been converted to burn coal, using underfeed stokers. The other ten furnaces were coal burning, but, of these, seven were fitted with underfeed stokers, one was fired with pulverised coal, one was a sulphur refining plant provided with sprinkler stokers and a very tall steel smoke stack, and one was a Lancashire boiler installation which is to be modified in the near future. The average chimney height for all these cases was 49 ft. 6 in., excluding two 375 ft. chimneys for a new electric power station.

The 41 projects which were queried included three sent back because of insufficient information. Eleven other proposals were queried because smoke producing fuels were to be used, and 27 because the proposed chimney heights were, in my opinion, too low. Undertakings were subsequently obtained that smokeless fuels would be substituted for the smoke producing fuels in the eleven cases just mentioned. The average height of the proposed chimneys in the other 27 cases was

34 ft., but, as a result of my representations, I have secured increases varying from 6 ft. to as much as 30 ft.; bringing the average chimney height up to 46 ft. These increases do not, of course, play any part in reducing smoke emissions, but they do help to minimize nuisances which might occur.

It has been the Corporation's policy for many years to require smokeless fuels to be used in new boiler plants. This policy still applies, but there is considerable difficulty at present in obtaining adequate supplies of such fuels. In particular, it is not easy to get allocations of special fuels from the Ministry of Fuel and Power. This has caused the Corporation to relax their policy in certain cases and allow coal to be used if coking type and underfeed stokers were fitted. Here again, however, it is not always possible to obtain allocations of graded coals suitable for use in these stokers and I have found, by experience, that the use of unsuitable fuels (for example—ungraded opencast coal) may give rise to nuisance because the high ash content causes the coal to clinker badly and so necessitates frequent disturbance of the firebed, and also because, in many cases, the lower calorific value of the fuel makes it difficult to meet steam demands without forcing the boilers. I have one case in mind in which the use of such coals with an underfeed stoker caused very strong complaints of nuisance to be received, although this particular plant had been in use for many years without complaint while burning good coal. Even in this case there was considerable difficulty in persuading the Coal Allocation Officer to grant supplies of more suitable fuel, and it was not until a statutory notice was served upon the firm and transmitted, in turn, to that Officer, that an allocation was given.

Another problem is the difficulty which sometimes arises in reconciling the differing views of the Health Department and the Town Planning Department about the height of a new chimney. In some cases we have compromised by accepting a lower height, subject to an undertaking being given that the chimney would be raised if nuisance occurred. In one or two instances this has meant that the foundations and thicknesses of brickwork have had to be adjusted so as to be ready to take the additional weight if the chimney has to be extended. In other cases the chimney had had to be re-sited away from the front of the building.—*James Goodfellow, Chief Sanitary and Chief Smoke Inspector, City of Leeds.*

The Testing of Domestic Fuel Burning Appliances

DURING the past three or four years the Fuel Research Station of the Department of Scientific and Industrial Research has extended considerably its facilities for testing domestic appliances for space-heating, cooking and water heating, particularly those designed for burning solid fuel.

In collaboration with other testing laboratories, appliance makers, and interested Government Departments, methods of testing have been selected and standards of performance for the various types of appliance have been drawn up. The tests are designed to provide information on efficiency and suitability under ordinary conditions of use in the home. Heat outputs for water heating and room heating are measured and efficiencies are determined at various rates and under different conditions of use. With cookers the effectiveness of the oven is assessed by cooking selected dishes, and the performance of the hot plate is determined by boiling tests.

In addition to the scientific measurements, each appliance is critically

examined in detail with particular reference to easy cleaning and maintenance, simple operation, and convenience to the housewife. Appearance is regarded as important, and by arrangement with the Council of Industrial Design, a panel of designers comments on each appliance.

Close collaboration is maintained with the makers of the appliances during the tests. The makers are invited to inspect the installation before testing is begun, and to visit the Fuel Research Station during the course of the tests. This close collaboration has resulted in many improvements, some of them quite important, being made to the design and performance of a number of the appliances.

Those solid fuel appliances which reach the required standards and fall within suitable price limits are included in the Approved List of Appliances for Low Cost Housing, drawn up by the Ministry of Fuel and Power in co-operation with other Government Departments; the list is circulated to Local Authorities.

In order to qualify for inclusion in the Approved List, appliances must have an efficiency much greater than those in general use before the war. They burn fuel much more efficiently and generally make it possible to achieve much improved standards of heating in the home at a reasonable cost and with a reasonable fuel consumption. One significant feature is that a large number of these modern appliances—open fires of various types, openable stoves, cookers, and combination grates—are suitable for use with smokeless solid fuels. Many of them are more efficient with the smokeless fuels than with bituminous coal.

Arrangements have been made to extend this work by the establishment of a Fuel Research out-station in Scotland, where a large proportion of the solid fuel appliances are manufactured.—*The Fuel Research Station.*

Smoke Prevention Device for Industrial Boilers

AT the Annual Conference of the Society held in Edinburgh last year Mr. T. F. Hurley of the Fuel Research Station of the Department of Scientific and Industrial Research gave a paper on "The Composition of Smoke." In this paper it was mentioned that during the war the smoke from merchant ships had been reduced or eliminated by the use of devices developed at the Fuel Research Station, and that after the war the same principles had been applied on land to hand-fired natural-draught shell type boilers, such as the Lancashire boiler.

The device* when used in this application takes the form of a special firing door. In the upper part of the door are two large nozzles with streamlined entry for the admission of a continuous supply of secondary air, and in the lower part is a large flap valve which opens automatically when the firing door is opened and admits the extra air required to eliminate smoke immediately after raking or firing. The valve is closed after a few minutes when the evolution of volatile matter from the coal has abated.

During the last year further tests have been carried out at the Research Station with various types and sizes of fuels and over a range of boiler loads; and the device was shown to be satisfactory under all the conditions tried.

Every opportunity has been taken to make the doors better known. At the time of the last Conference they had already been described in various technical journals, and lectures and

* "A Smoke Eliminator for natural draught Lancashire Boilers" by T. F. Hurley, Fuel Economy Review, 1946. "Recent Advances in Smoke Abatement based on the work of the Fuel Research Station" by T. F. Hurley. "Institute of Fuel," August, 1947.

demonstrations had been given to numerous individuals and organisations. Nevertheless there were only a few in commercial use, and it was suggested at the Conference that the smoke eliminator doors should be given increased publicity. Since then the earlier methods of publicity have been continued and others have been tried.

In January, 1948, the doors were mentioned in the first of the series of broadcasts known as "Progress Report." As the direct result of this broadcast a large number of enquiries was received.

A full-scale model of the door has been exhibited at three Engineering Exhibitions, at each of which a member of the Station staff was present to give full information. The exhibits aroused considerable interest and were freely and favourably commented upon in the Press.

Two firms have recently arranged to make and to advertise the firing door commercially, and other firms are seriously considering undertaking its manufacture. Although only a few have been fitted the reports received up to date are encouraging.

The device has not been patented and it can be manufactured without royalty or other fees by anyone. The Director of Fuel Research will be pleased to give every possible assistance to any who may wish to use the doors or to make them either for their own use or for sale.—*The Fuel Research Station.*

Bristol Smoke Control Committee

FOR many years Health Departments have been trying to secure a cleaner atmosphere by the *abatement* of smoke and grit nuisances, but it is now realized that a new approach by means of *prevention* is required if new plants are not to be adding their quota of pollution to that produced by existing offenders.

With a growing realization of the measures necessary to secure this desired result the Bristol Health Committee convened a meeting during 1946 when the Chairman and officers of the Planning and Reconstruction, Housing, and Health Committees were invited to be present. The Chairman (Alderman J. J. Milton) welcomed the Secretary of the National Smoke Abatement Society who referred to the unique nature of the meeting which was also attended by the Town Clerk, Medical Officer of Health, City Engineer, City Architect, City Valuer, Housing Manager, Public Analyst, and the Chief Sanitary Inspector with his Deputy.

A wide range of methods which if adopted would have an influence in producing a cleaner atmosphere were discussed including District Heating, Communal power schemes for trading estates, new domestic heating appliances and the creation of a smokeless zone.

Following a report to the Health Committee on the interest created by the inaugural meeting it was decided to establish a *Bristol Smoke Control Committee* consisting of three members of the Planning and Reconstruction, Housing, and Health Committees with the principal officers concerned. The importance of smoke prevention in reconstruction and new housing schemes has since been fully discussed by the various committees with representatives of the Smoke Control Committee. This has resulted in special consideration being given to cleaner methods of heating when plans are submitted and to the installation of multi-fuel and smokeless grates in all new houses built by the Corporation.

This co-operation was also evident when, following the submission of plans to reconstruct a local gas works it was decided to invite the Chief Sanitary Inspector to accompany a deputation to the Torquay Gas Works so that the Council members and officers could see methods of gas production under the most cleanly conditions.

The Bristol Smoke Control Com-

mittee considered the new legislation proposals of the National Smoke Abatement Society. The Bristol City Council nominated the chairman of the Health Committee (Alderman J. J. Milton, J.P.) to serve on a special Committee set up by the Association of Municipal Corporations, to receive the views of representative local authorities, and following full discussions in each case, decisions were made to support these proposals in principle.

Thus it will be seen that the active interest of a team inspired with a desire to pursue new methods has been established not only to see what can be done at the present time, but also to consider the most satisfactory administration of any new legislation.

A further indication that those interested with new construction are conscious of this important matter is evident by the presence at this conference of Mr. J. Nelson Meredith, the Bristol City Architect, whilst the Chief Sanitary Inspector has been invited to address a meeting of the Faculty of Architects in the Western Region on the part which can be played by private and public architects in connection with this matter in the future.—*F. J. Redstone, Chief Sanitary Inspector, City of Bristol.*

Dust Nuisance from Cement Works

THAMES-SIDE AREA

IT will be remembered that at the Conference of the Society held in October last the question of the dust nuisance from Cement Works in the Thames-side area was brought before the Conference, and mention was made that a Conference of Local Authorities and other bodies interested in the matter was being held at Dartford towards the end of the month.

The Society was represented at that Conference and it will be observed from the 18th Annual Report that a Representative Investigation Committee was set up. The Investigation Committee has held a number of meetings.

At one of the meetings representatives of the cement industry, the Chief Inspector of Alkali, etc. Works, Ministry of Health, as well as the Deputy Chief Inspector and a representative of the Ministry of Works, attended, when the representatives of the cement industry stated that they could reduce the dust nuisance very considerably if they could obtain dust extraction plant required at the factories. but that due to the economic position, particularly in regard to allocation of steel, they were unable to obtain delivery of plant required.

Representations have been made to the Minister of Health through the local Members of Parliament, and a communication recently received from the Parliamentary Secretary to the Ministry of Health stated that the Minister had been in communication with the Supply Ministry who were making enquiries into the manufacturing position of dust arresting plant and that while these enquiries were not yet complete, it was learned that the plant required for one of the works on the Kent side of the Thames would be ready in July, and that extensive renovations were being undertaken at a second works which should be completed by the end of November.

The Member of Parliament for West Thurrock was successful in raising the question on May 7th on an adjournment of the House of Commons, when a promise was made by the Parliamentary Secretary to the Ministry of Health that he would certainly do all he could to push forward the production of precipitation plant.

The Members of Parliament urged that the Minister should view for himself the effects of cement dust in the area.

The Investigation Committee, after consultation with Dr. A. R. Meetham,

have arranged to collect evidence and statistics by the use of Petri-dishes of the amount of dust falling in the area, such dishes to be placed on sites suggested by Dr. Meetham, on approximately sixty different sites, and that at least sixteen tests should be taken.

Dr. Meetham then suggested that the County Analyst should be asked to analyze each sample, giving information as to :

(1) the weight of each sample with the name of site and the date.

(2) the combined samples of one day to be analyzed for calcium determination.

(3) heavy samples only to be analyzed.

At the end of June four tests had been taken by means of the Petri-dishes, but at the time of writing there is no report from the County Analyst as to the interpretation which can be placed upon the tests.

Petitions against the dust nuisance have been organized by a number of Local Authorities in their respective areas, and more than 4,500 signatures have been obtained urging that all possible steps be taken to abate the nuisance from cement dust arising in the respective districts.

Communications have also been addressed to the local branches of the National Farmers' Union to ascertain whether any claims had been made in respect of loss sustained by Fruit Growers as the result of the deposit of dust upon the fruit and other vegetable produce grown in the area.

While the Committee have received evidence that growers did suffer a loss through the cement dust owing to crops looking shabby and requiring additional washing to make them fit for market, no evidence has been obtained showing the actual cash loss per acre.

The collection of evidence is making rather slow progress and the result of the Committee's investigations are not yet complete. The recent unsettled weather has prevented further tests being taken by means of the Petri dishes, and it is this evidence which is most important to the Committee before they can prepare the final report. It may be that by the time the Conference is held in October next, the work of the Committee will be completed and a full report can be submitted.—*O. James, Hon. Secretary, Investigation Committee, Clerk to the Council, Rural District Council of Dartford.*

Central and District Heating Schemes

PROGRESS on these schemes has been steady, and a number of Central Heating Schemes have been accepted by various Councils and Ministries concerned. The London County Council have at least six schemes of Central Heating in progress to large blocks of flats; Holborn, Paddington, Edinburgh and Glasgow are also moving on these lines. The Paddington scheme is a large one, the first section comprising 900 flats, most of these in ten storey blocks, and one of the Glasgow schemes also propose a ten storey block, and central heating is proposed.

On the schemes covering larger areas (though not necessarily a greater number of dwellings), a special committee of the various Ministries has been set up to consider District Heating, and so far has approved of a number of schemes in England.

These are as follows :

	No. of Houses
Bilston	350
Brynmawr	838
Coventry	
Dagenham	850
Hounslow	345
Luton	1,750
Pimlico	1,690
Salisbury	522
Twickenham	900
Urmston	1,317
Wythenshawe	7,585

Swindon is also considering a scheme for about 1,100 houses.

In Scotland a scheme is in progress at Bonnyrigg and a commencement has also been made on a District Heating scheme to the first section of a new town at East Kilbride, which it is expected eventually to comprise 10,000 dwellings and all public buildings in the area. Two other schemes in Scotland under consideration are at Pristhill, 560 flats, and Woodside, Fife, 340 houses.

Most of the above schemes are purely Thermal Schemes, but Coventry, Pimlico and Wythenshawe schemes are Thermal Electric while possibly Luton and Swindon, if adopted, though thermal schemes in the initial stages, will ultimately become linked with Power Stations.

Of the schemes mentioned those on which construction has actually begun are Urmston, Salisbury and Pimlico, and on the former of these three the first 100 houses are already connected up and working.

It is hoped by the time this report is presented to the Conference, some further interesting data about some of these schemes will be available.—*Donald V. H. Smith.*

The Salford Corporation Act

A noteworthy feature has been the emergence of powers designed to implement the Society's policy for the progressive elimination of smoke. The bill, now the Salford Corporation Act, takes its place on the Statute Book but not without occasioning alarm for its safe passage at times.

Three sections deal with smoke abatement :

(1) Gives power to control the heights of industrial chimneys.

(2) To secure the application of the principle of prior approval to all proposed new furnaces.

(3) To establish " smokeless zones."

Very little opposition was presented to item No. 1. Under the second heading the original Bill was designed to give control over all types of heating appliances but it was deemed politic to be satisfied with similar powers to those contained in the Manchester Act. The opposition to our attempt to extend control was keen and obviously gaining favour with members of the Lords Committee. To operate this section an advisory panel of experts on which the Health Committee, the Building and Development Committee, and the Ministry of Fuel and Power (Fuel Economy Section) are represented has been constituted.

Opposition to the " Smokeless Zone " proposals was no more than anticipated and thanks to the use of arguments developed by the Society and constant quotation of " Simon Report " recommendations the clause was admitted without alteration, but it should be noted that " Smokeless Zone " declarations are subject to approval by the Minister of Health and liable to Local Enquiry.

A further forward step has been taken. After tentative enquiries and being satisfied about the availability of smokeless fuels locally the three-stage project was explained to a meeting of the local merchants operating in the City and, commencing with a degree of antagonism on their part, they were satisfied that they had, by having a preview of the projected design, a reasonable opportunity of catering for, and cultivating a greater demand for smokeless fuels. Certain difficulties, not entirely unknown to us, were referred to and grievances ventilated. Illustrative of the spirit of co-operation engendered by the meeting is their proposal for a further discussion with the promotors of the scheme, the local coke producers, the Fuel Overseer and their own representatives for the purpose of ironing out the difficulties and further their expressed willingness to exhibit smoke abatement posters in their offices, particularly if the posters advocated the use of readily obtained

smokeless fuels.

Easement in the staff situation has permitted a partial resumption of the pre-war observations of industrial smoke emission and a survey of an area covering approximately one third of the City. It led to the discovery of three cases of overloading. In one of them, a laundry, an old vertical boiler is being replaced by a 31 ft. Lancashire boiler; in another, a brewery, the installation of economizers is advocated, whilst in the third, another laundry, the Lancashire boilers, incapable of being operated at high pressures through excessive wear and tear, are being replaced by new ones and the flues and settings overhauled. Other items of modernization will probably be carried out at the same time. The boiler house visits revealed a feature to which attention was directed on several occasions. Stokers, in their endeavour to counteract the high ash content and clinkering effect of low grade coal, are inclined to remove too much partially consumed fuel, sometimes to the extent of completely emptying the furnace. Apart from wasting coal it gives rise to the creation of volumes of dense black smoke, and the practice is much to be deplored.

Grit emission nuisances have increased considerably. The usual cause is a very high draught, often higher than necessary. Such cases are easily rectified, but in one case, that of a dyeing and bleaching works, nothing short of high expenditure on cyclonic grit arrestors, for which there was no space available, had to be advised. The firm was persuaded to take a long term view and decided instead to construct a new power-plant incorporating water-tube boilers and other modern equipment. The work is well in hand and will be a distinct improvement in an area already zoned for residential purposes.

On the whole, there is a noticeable improvement in the quality of coal supplied to industrial boiler-plant and the Ministry of Fuel and Power are to be complimented for their endeavours in this direction whenever occasion has demanded their attention being directed to a particular case, but many firms need to be reminded that coke is a very suitable fuel for use in vertical boilers.

The practice of making domestic coke available to tenants of all new houses equipped with "approved" appliances continues and undoubtedly more success could be achieved in ensuring the continued use of this fuel were time and staff not such important factors, but in any case that problem will eventually be solved when the "Smokeless Zones" come into being and the delivery and use of bituminous coal is prohibited.—*J. L. Burn, Medical Officer of Health, Salford.*

Joint Discussion on the Survey and the Progress Reports

Dr. R. Lessing (London) said that at the last Conference held in the West Country, at Bristol in 1935, he had concluded a paper on "The Sources of Atmospheric Pollution" with a proposal for instituting a survey of the contributory causes of this evil. At long last a modest beginning had been made. As Chairman of the Technical Committee he wished to express the Society's appreciation to Col. Cousin for the pains he had taken to perform a somewhat thankless task. The response to the inquiry was excellent in some, inadequate in others, and was not forthcoming at all in far too many cases. Col. Cousin had to cut his coat according to the diversified material at his disposal and this resulted in a garment of many colours and tattered in parts. The Society looked to those authorities who had tackled the job in earnest, to give their assistance by continuing their watchfulness and to

report the effects of the Society's good work in their areas. Eventually the survey would have to be intensified on the one hand by testing the air for polluting matter, and on the other by tracing the offending chimney emission to its original source, the combustion appliance and its fuel.

One point in the report should be stressed. Putting the blame on inferior fuel was not justifiable as a generalization. Dr. Lessing's record cleared him of any accusation of being an apologist for dirty coal. He could therefore say in good conscience that high ash in coal, however indefensible technically and economically, did not promote smoke formation. But, and a very grave but, the natural dust in coal was most objectionable and was indeed one of the major sources of atmospheric pollution, being almost entirely responsible for the emission of grit and flue dust.

If dust, as distinct from "fines," which were much coarser, were extracted from all coal before cleaning or even from coal not to be cleaned owing to the present inadequacy of preparation plant, it could be burned without loss in pulverized fuel furnaces. This would entail the efficient utilization of several million tons of a portion of the coal which now escaped unburned or only partially burned, to create the appalling nuisance which we wished to eradicate.

D. C. Cross (Institution of Gas Engineers and National Coke Federation) said he proposed to confine his remarks to the paragraph on grit pollution from gas works. He agreed there was little remedy for smoke and dust from horizontal retort houses, but pointed out that 56 per cent. of the gas manufactured in gas works now came from vertical retort houses, where it was practical to eliminate most of the smoke and dust in the retort house.

In several gas works, a system of vacuum fans had been installed which successfully trapped the coke dust during extraction of coke from retorts, as this was the chief source of grit. He did not agree with the statement that there was no remedy for grit in the blast from water gas plants. He could state from his own experience that it was possible to install grit catchers or arresters on the top of water gas stacks which were very efficient in stopping the discharge of grit. Many of the water gas plants in the country were fitted with these grit catchers and were working satisfactorily. He had installed with success a grit catcher on the top of a steel chimney attached to a battery of Lancashire boilers burning only fine coke breeze and using forced draught. This is a severe test on the efficiency of these grit catchers, and he was proposing to extend the system to all steel boiler chimneys.

Another source of dust arising from gas works or any other works where a mechanical coal wagon tipper was in use—he had observed a cloud of coal dust every time a wagon was tipped. As his works had a food factory adjoining the retort house, steps had to be taken to eliminate this coal dust, and a successful remedy had been found by installing a system of 60 fine water sprays around the receiving hopper which created a fine blanket of water spray over the coal when it was tipped and had trapped any coal dust arising.

He finally wished to refer to the high price of coke in some areas of England, which was perhaps out of step compared with the present price of gas or even coal.

During the war it was the policy of the Government to stabilize the price of gas and encourage gas undertakings to place the additional cost of production on coke. There is no questioning the fact that the price of coke has risen at a much higher percentage than the price of gas, and this has been recognized by the fact that in the last increase in price of coal, many gas undertakings did not increase the price of coke but raised the price of gas to meet the increased cost of production.

He felt that if the gas industry had more freedom of control of the price of gas and coke, then the price of coke would in time be adjusted to its economic comparable value.

James Law (Sheffield, Rotherham, and District Smoke Abatement Com-

mittee) said he was very pleased to have the opportunity of expressing his grateful thanks to the Society for their enterprise and initiative in attempting to record a survey of the atmospheric conditions throughout Great Britain. It was the most illuminating piece of work that had been attempted during the past thirty years and should give every delegate at the Conference food for very serious thought.

Last year at Edinburgh he had stated that it was with a feeling of frustration regarding the lack of progress made in other areas that made him wonder if we were serious with regard to smoke abatement? He criticized the existing Regional Committees and their work.

This survey had shown very definitely that the apathy and lack of interest was more widespread than any of them had thought possible.

In England only 47 per cent. of the local authorities thought it necessary to reply and of that number a further 10 per cent. were of opinion that there was no atmospheric pollution problem to consider so that only about *one third of the population of England* was smoke conscious.

In Scotland 31 per cent. of the local authorities replied and 7 per cent. had no problem so that smoke consciousness in the north was only 25 per cent.

These were inferences that must be accepted and faced up to if smoke abatement was going to become something more than a toy or a plaything for people when they hadn't much to occupy their minds.

The pollution of the atmosphere was a continuous process: it went on day and night throughout the years and if it was to be controlled the methods must also be continuous, not at a Conference once a year, which one forgot about until the next Conference.

If a survey was made of the number of Inspectors who are doing smoke abatement work as a full-time occupation it would be found that the total number was only twenty-five.

With regard to standards of assessment, if there were no instruments in operation to give records of what was happening, they were only making a poor guess and that was apparently what was being done by more than half the local authorities in this country. Pollution recording gauges were not expensive, they didn't require an amount of daily attention, but they did give an indication of the conditions of the atmosphere. They were not to continue guessing, but to make some records to show what is happening.

Much discussion had taken place with regard to fuel supplies and as an excuse an amount of careless stoking and bad appliances had been attributed to the fuel supplied. A census of the Sheffield area in 1946 showed that in the majority of cases, the fuel was as good if not better than that used in 1938. If the boiler plant was adequate to take the load imposed and the appliances were good, the quality of the fuel was not of paramount importance. Greater discrimination however was necessary that at present, for the use of ungraded slack with sprinkler stokers was certain to cause grit emission. The indiscriminate use of forced draught had the same effect.

Here he would also offer some criticism to the Ministry of Fuel and Power with regard to fuel supplies. Sir Stafford Cripps was asking for an increase of at least ten per cent. in the output of manufactured goods for export. Mr. Gaitskell was insisting on a ten per cent. degrading of all fuel supplies for manufacture in order that the graded fuels could be used for export. How could manufacturers increase their output to any extent with a lower grade fuel? This was a serious matter that needed adjusting. As smoke abatement officers, the indiscriminate use of ungraded fuel and forced draught was becoming a menace and was not in the interests of the manufacturer or the community. If they had any doubts about this matter they were to watch the increase in the pollution deposits in the industrial areas.

Had the survey been worth while? It had shown up the apathy of many, the ignorance of some and the necessity for much greater efforts on the part of

the local authorities, manufacturers and technical officers to control and prevent the increase of pollution which was taking place throughout the country.

Dr. A. R. Meetham (Fuel Research Station of the D.S.I.R.) agreed that it was important, where possible, to measure the atmospheric pollution in districts before industrial or domestic development took place. Measurements of that kind were already being made in a number of places including Stevenage, where a new town was being built.

There was reason to be pleased with the results of the tests which had so far been made by the Investigation Committee of local authorities in the Thames-side area. This was the first time petri dishes had been extensively used for rapid surveys of the deposition of dust in the neighbourhood of cement works, and the surveys were yielding reproducible and intelligible results.

Mr. Marsh had mentioned deposits of 3-4 tons per day on a square mile in this area. In the nearby industrial district of East Greenwich in the same period, the deposits were only 1-2 tons per square mile per day, and in the remoter parts of the Thames-side area surveyed, deposits of less than ½ ton per square mile per day were common. There were signs, however, that since April, 1948, the deposit near the cement works had diminished appreciably. Was this due to a reduction in the dust emissions from the cement works ?

The percentage of calcium in the heavier deposits collected at Thamesside was usually 20-30 per cent., whereas pure cement-works dust contained about 40 per cent. of calcium or perhaps more. The inference must be that some of the dust collected was not from cement works.

Dr. Meetham pointed out that observations with petri dishes were not made in average weather conditions but in periods of dry, fairly calm, weather. They could not be used instead of deposit gauges for measuring the average rate of deposit, and experience had proved that petri dishes tended to give results about 1½ times as much as the insoluble matter collected in deposit gauges.

W. A. Damon (Chief Alkali Inspector, Ministry of Health) referring to the Thames-side Cement Works, said that the demand for cement had risen from two million tons in 1921 to eight million tons in 1939. From 1935, when it was established that electrical precipitation was a practicable means for dealing with cement kiln gases until 1939 a large number of such plants were installed. With the outbreak of war the demand for cement fell and a number of plants were laid idle. At the cessation of hostilities it became necessary to step up production again rather violently and it was then found that most of the electrical precipitation plants had suffered so much corrosion as to be virtually unworkable. The cement companies had done their best to restore conditions but were severely hampered by shortages of steel plate and electrical equipment. Supplies were, however, now coming in slowly but steadily and good progress had been made in the past twelve months.

Equally with the emission of dust via kiln chimneys, that from ancillary processes such as grinding, transportation and bagging of cement could be a serious factor in local pollution. This matter was not being overlooked. At least one complete bag filtering unit had been installed, three more were in process of installation and quite a number were on order.

There had been a definite improvement in conditions during the past twelve months and equally definitely there would be a further improvement in the next twelve months but it was necessary to sound a note of warning. About half of the total cement production of this country was concentrated in the Dartford-Grays-Gravesend area and he feared that so long as this huge production continued in such a limited area—even when everything had been done that could be done—the irreducible minimum of dust emission would still be such as to cause complaint.

Councillor John Duffus (Bexley) thanked the Secretary—Mr. Arnold Marsh, Dr. Meetham, and the Technical

Committee of the Society, for the help given to the Thames-side Cement Dust Investigation Committee.

Speaking on behalf of the Committee, he was pleased to report that the cement manufacturers had agreed to install electrostatic precipitators in all their factories, and when installed, 95 per cent. of the nuisance would be eliminated. It was rather unfortunate that this agreement had been reached during a steel shortage ; these firms had plenty of opportunity to install pre-war when there was no shortage of steel. However, better late than never.

The Executive was asked to support the application for steel to construct the electrostatic precipitators.

The full case would soon be ready to present to the local M.P.'s and despite the Chief Alkali Inspector's rather pessimistic report, the Committee felt sure that the Minister of Health would give favourable consideration to the appeal for steel.

G. Nonhebel said that he was speaking as a private member although he was connected with industry. He proposed to confine his remarks to the view point of the designer and manager of plant.

He referred to the conference held at Leeds on "Dust in Industry" and said that the emphasis there during the discussions on plant performance was on measurement of concentration and particle size and stressed the importance of the expression of performance in quantitative terms. He referred to recent local acts containing smoke abatement provisions and pointed out that the relevant sections provided only that furnaces were to be as far as practicable capable of being operated continuously without emitting smoke. There was, however, no definition of smoke so that on a strict interpretation even a thin haze coming from a chimney could be called smoke.

He suggested that members should think about more precise definition of industrial smoke and reminded them of the paper read at last year's conference by Mr. Hurley of the Fuel Research Station which showed that with certain types of boilers the lowest loss of heat in chimney emissions was when there was a light grey smoke as measured with an optical device. Here was a suggestion for guidance on measurement in quantitative terms which could, with suitable instruments, be measured and recorded.

If bad smoke were defined as slightly worse than that which had been shown to give the highest efficiency of operation that would be something managers of plants could understand and if instruments could be installed managements could then see that their plants were complying with the regulations in force.

If some positive figures could be put forward as to what were considered reasonably good conditions in industrial districts designers of plant would have a better idea of the standard to which they should design.

John Roberts (Cheltenham) drew attention to a paragraph on page 18 referring to grit from coke ovens. It seemed to him extraordinary that the local authority were being pressed to erect aluminium pre-fabs close to a battery of coke ovens where it was said that nuisance arose from grit. It was simply asking for trouble to erect the pre-fabs there. In his view, smoke abatement was not everything ; industry came first. One must earn one's bread first, and then seek a place to eat it more or less in comfort. Besides, the coke oven industry was a smoke abatement industry.

Mr. Roberts then went on to describe an example of wasteful combustion of smoky coal in a well-known hotel in that town. His object in so doing was to stress the fact that if the raw coal were first treated in, say, the Mansfield retorts to eliminate 25 per cent. of volatile matter, the remaining 75 units of smokeless fuel would radiate more heat into a room than would the 100 units of raw coal.

J. Price Walters (Ministry of Fuel and Power) made a plea on behalf of the Engineers of Hospitals and Institutions and stated that he welcomed this opportunity of emphasising their importance to representatives of local authorities. It not infrequently hap-

pened that, when a Ministry Engineer visited an Institution at the request of an Administrative Officer, he found that most of the recommendations he had to make had already been made previously by the Engineer, only to be turned down on grounds of cost, without the consideration the suggestions deserved. He felt that the raising of the status of the Hospital and Institution Engineers would encourage well qualified men to apply for these posts, with great advantage to the local authorities concerned.

Mr. Price Walters then referred to the contribution by Councillor Young (Gateshead) and stated that he was very interested to learn that tenants of all-electric houses had expressed the view that the amenities more than compensated for the absence of the " cheery open fire." He considered that this augured well for the whole house heating demonstration about to be conducted by the Ministry in various parts of the country, one of the objects of which is to ascertain whether British tenants will appreciate the amenities thereby provided and prefer them in spite of the absence of an open fire. Unfortunately, there would not be a demonstration in Gateshead but he invited Councillor Young to keep in touch with the Ministry's Regional Office in Newcastle, so that he could visit the demonstration at Doncaster as soon as the houses were complete and tenanted.

Councillor W. P. Stagg (Thurrock, Essex, U.D.C.) stated he was from the Thames-side cement producing area; such district comprised 40,000 acres and a population of 74,000. Conference had heard Dr. Meetham on the results of the investigations made so far at the instigation of the joint body representing the local authorities on the Kent and Essex sides of the Thames cement producing area. Conference had also listened to his friend Councillor Duffus of Bexley on this nuisance and he did not therefore desire to stress the matter again from that angle. He did however desire to express what in his opinion was necessary to ensure a limitation of smoke and grit nuisances.

Councillor Stagg then went on to state that it was his opinion that appointments as Smoke and Grit Inspectors in each area were necessary and their duties should comprise the work of the Alkali Inspectors and possibly the Factory Inspectors so that complete supervision of factories was undertaken. Conference knew only too well that an efficiency of 95 per cent. could be obtained by the use of electrical precipitators but a minimum of 80 per cent. for the time being might be satisfactory until the supplies position became more easy.

The salaries of such inspectors should be borne by the Ministry of Health, the prime duty of that department being the health of the nation; in fact the cost might be reimbursed to that body by the saving of doctors' salaries. Reports upon all factories in the area would be made by such Inspectors, in the first case to the local authority, and periodical reports made to the Ministry.

Councillor A. Stewart (Corby) considered there would have been a much better response to the national survey, if the forms had been sent to the responsible official, that is the Sanitary Inspector.

Regarding the Progress Reports, and the statement at the general meeting that the Society had approached the British Electricity Authority, he suggested that they should now approach the Iron and Steel Federation.

Deposit gauges had been set up in Corby in May, 1948. In three out of the following four months, the records were the highest published in Great Britain; in the remaining month, they were only beaten by Wellingborough. No other district came near those results. The deposits recorded in the four months were (in tons/sq. mile) 111.69, 79.47, 73.77, 90.19. Certainly Corby, and probably Wellingborough, did not like being top of the pollution league!

Now, Corby had no legal powers, but could only use persuasion. Even if they went " cap in hand " to the works, and thereby reduced the figures by, say, 50 per cent., even then the deposits

would be considerably higher than most places.

F. W. Brick (Publicity Officer, Coal Utilization Joint Council) pointed out that the erection of all-electric and all-gas houses (suggested by Mr. Young, of Gateshead), did not offer a practical solution to the problem of domestic smoke pollution, since 80 per cent. of the total domestic heating load was taken by solid fuel. The ultimate solution, he suggested, depended upon the installation in all new houses now being erected of improved appliances which burned bituminous coal more efficiently than pre-war types and which could burn solid smokeless fuels when these are more freely available than they are to-day.

Mr. Brick said that many local authorities were still installing inefficient appliances of pre-war design, and in general they advanced one of three reasons for this: (1) The long delay in delivery of the improved appliances, (2) that the extra capital cost of the improved appliances would bring the price of the houses above the ceiling permitted by the Ministry of Health, and (3) that they could not afford the extra capital cost involved.

Dealing with the first point, Mr. Brick said that the production of improved appliances was now ample for all new housing and that if the local authorities placed their orders when the plans were passed and did not wait until houses were in course of erection, they would receive the appliances in ample time for their requirements. With regard to the second point, he said that on the 20th April, 1948, following representations by the Coal Utilization Joint Council, the Ministry of Health had issued a circular to local authorities (No. 61/48), which stated:

> "The Minister attaches great importance to the extended use of efficient modern solid fuel appliances and will take into account any additional cost involved when he considers tenders submitted for approval."

On the question of the extra capital cost involved, Mr. Brick said that a fuel saving of £1 5s. 0d. a year justified an extra capital cost of £10 assuming that the life of the appliance would be only ten years—and the life was more likely to be 30 or 40 years. He thought that if given the opportunity, tenants of houses would willingly pay an extra sixpence a week on their rent in order to have the benefits which the new appliances offered—improved performance, saving in labour and in cleaning, and reduced fuel costs.

Mr. Brick concluded with an appeal to the Society to concentrate all its resources on the task of persuading local authorities to install the latest improved solid fuel appliances in their new houses. He said there could be no ultimate solution of the domestic smoke problem so long as new houses continued to be installed with old-type appliances which would probably still be there in thirty or forty years' time.

Dr. Greenwood Wilson (Cardiff) began by saying that he welcomed the opportunity of paying public tribute to the pioneer work of Mr. Donald V. Smith in the cause of district heating. He regretted that that work had not been followed up very vigorously throughout the country, particularly at a time when with such vast building programmes, there should have been so many opportunities of including district heating schemes in the new Council Housing Estates. It seemed not to be generally understood that although such schemes would put up the rent perhaps five or six shillings per week, this would be more than offset by the saving of fuel (coal, electric or gas) and by the incalculable advantages to health and comfort that are brought to the homes of the people by district heating. He stressed the greatness of the boon to health, cleanliness and happiness of housewife and family conferred by constant hot water—one of the advantages of district heating schemes.

He also pointed out that with the central heating systems in each house, that it was possible to associate with district heating schemes, they could have here, as on the Continent, a healthier and happier use of each home. Instead of the family in winter time

having to crowd round the one source of warmth in the living room, distracted by the varying pursuits followed by individual members of the family, they could use to the full every room in the house including the bedrooms. For example, children could do their home work in their bedrooms in peace, whilst other members of the family downstairs could enjoy the wireless without feeling that in so doing they were distracting those members of the family who needed quiet for home work, reading, etc. Dr. Greenwood Wilson concluded by urging that the National Smoke Abatement Society should bring all pressure to bear on Central and Local Housing Authorities to speed up the provision of district heating schemes throughout the country.

James Law replying to the discussion said that as a number of technical questions had been asked during the discussion it appeared that in fairness to the questioners, some suitable replies should be made. Mr. Nonhebel asked about smoke " in such quantity as to be a nuisance " which was not a simple matter.

" Smoke is a nuisance when it becomes opaque on leaving the chimney top—irrespective of the colour—the ' Time Standard ' varies, but in most cases must not exceed two minutes during any observation of 30 minutes' duration." Grit was not so easy and must be collected on grit slides or petri dishes and proof given that it came from a specified chimney. Though the size of the grit particles were important and resolutions had been put with regard to size and quantity, the British Standards Institution had not been able to give a definite specification with regard to this matter. Prosecutions had taken place for excessive grit emission, which was a growing menace and the use of inferior low grade fuels is increasing the amount of deposited matter daily.

Mr. Max Young asked similar questions to which he hoped this reply would be satisfactory.

Mr. John Roberts stated that coke ovens were large contributors to smoke abatement on account of the coke they produce, but he did not inform them about the nuisance caused to residents in the vicinity of those coke ovens, both from " green gas " and sulphur-laden vapour from quenching. The amount of nuisance caused in this manner could be much worse than factory chimneys in an industrial town.

Mr. Ellis of Bermondsey had complained of ships in dock and wondered who was responsible for the nuisance caused. The local authority in which the dock was situated was directly responsible for this smoke nuisance and the Public Health (London) Act 1936, Section 3, gives them power to deal with such nuisance. In Liverpool very stringent action used to be taken to control smoke from shipping which could become a serious nuisance if efforts were not made to control it.

Mr. Stewart of Corby had stated that his authority had the highest pollution records in Great Britain but this was not strictly correct as Scunthorpe in Lincolnshire showed higher records. In both these towns as well as Wellingborough, blast furnaces and Bessemer Converters were in continuous operation and as these were basic industries and the impurity from the material was blown into the atmosphere, the nuisance was serious and should be controlled. Electrostatic precipitation would hold a considerable amount of the deposit if the users would go to the expense of installing such apparatus. Failing this action, it was possible that the people who lived in the vicinity of these works could take civil action and ask for an injunction against these people for material damage. This had been done in Sheffield with satisfactory results, the offenders having been compelled to install suitable apparatus to collect the dust.

SMOKE ABOLITION AND THE PUBLIC: PROBLEMS OF EDUCATION AND PROPAGANDA

By LESLIE HARDERN

I THINK we would all agree that we shall never achieve the aim of the National Smoke Abatement Society—the complete abolition of smoke in Great Britain—until we have created an active public opinion in its support. I stress the word active because there is plenty of passive luke-warm support, but that does not get us anywhere. There is also a certain amount of passive resistance on the part of those who would have to spend money making changes to their fuel burning equipment.

Our problem is how to fan this passive support into popular enthusiasm and how to overcome this passive resistance. Once we have reached that point the Government Departments and local authorities will have no difficulty in passing the necessary legislation and by-laws, the manufacturers will be able to produce the right appliances, the firemen and stokers can be taught to operate them properly, and the inspectors will be able to supervise their operation.

Education and persuasion of the public to-day on any issue can be achieved more rapidly than ever before in history. The task of achieving it, however, has become much more complicated and expensive than ever before. It is no longer a question, as when Wilberforce was fighting for the abolition of slavery, of just travelling round the country addressing audiences, publishing and distributing a small number of books and pamphlets, writing articles in a few newspapers with limited circulation, and lobbying Members of Parliament. It involves the use of a very wide range of modern media of propaganda. A full sized national campaign of this kind is beyond the resources of all but Government Departments, or large and wealthy industries. Smaller concerns, and particularly Associations and Societies like the National Smoke Abatement Society, with limited resources, cannot hope to compete on such a scale, and have to be content with attaining their objects in a much longer period of time. They can, however, shorten this period by a careful study and selection of those propaganda methods which are within their means.

I propose, therefore, to outline in this paper modern propaganda methods, to give some idea of their respective costs, and to make tentative selections of those which, in my opinion, would give the best value to the National Smoke Abatement Society.

Advertising

Advertising can be considered under the headings of (*a*) Press, (*b*) Outdoor, (*c*) Indoor and (*d*) Direct Mail.

(*a*) *Press.* Press advertising is the most usual method adopted for directly influencing the public. It covers the national, daily and weekly newspapers, the provincial and local newspapers, magazines and periodicals, trade, technical and professional papers, and a miscellany of annuals, guide books, estate booklets, church magazines, exhibition handbooks, sports' programmes, etc. One medium sized advertisement a week in the majority of these papers costs in normal times at least £150,000 a year.

(*b*) *Outdoor.* A poster campaign on outdoor hoardings, on railway stations, on the sides of buses, trams, trolley buses and commercial vans, and by the

use of illuminated signs, costs something like £75,000 a year.

(*c*) *Indoor.* Cinema slides in the majority of the cinemas in the country cost about £20,000 a year in rents, and short advertising films costing about £1,000 each to produce, cost about £25,000 each in rents. Assuming three films a year, the outlay would be £78,000.

(*d*) *Direct Mail.* A letter or leaflet sent by post to every household once a year runs away with about £65,000.

Publications

A full programme of publications includes booklets, brochures, leaflets, diaries, catalogues and a variety of gadgets. The cost depends, of course, on the number issued, but a reasonable figure for a full year, after allowing for revenue from sales, would be not less than £30,000.

Press

A constant stream of news items and articles is submitted to the national, provincial and local press, magazines and periodicals, the trade, technical and professional papers. Letters to editors are sent at all appropriate opportunities, either providing information or correcting errors. Press conferences are arranged frequently to make announcements of policy and developments; press previews of any displays or exhibitions are held, and publications sent to all suitable papers for review.

A properly staffed press department has officers to deal with the national press, the trade, technical and professional press, and the women's press. These officers not only provide information, but write up articles and submit them for publication. In addition they engage free-lance journalists for special articles. The cost of such a press department would be about £5,000 a year.

B.B.C.

Every opportunity is taken of supplying information to the B.B.C. either in the form of happenings in the Society, for the news announcements, provision of scripts to broadcasters, or the offer of speakers able and willing to broadcast. This work is handled by the press department mentioned in the previous paragraph.

Platform Publicity

There are numerous opportunities of providing speeches to Rotary Clubs, Chambers of Commerce, professional and technical bodies, women's organisations and political groups, etc., and lectures to schools and educational establishments. Speakers and lecturers are engaged, and three or four can cover a large number of audiences all over the country. The cost of such speakers and lecturers amounts to some £2,500 a year.

National, Regional and Local Conferences are useful methods of bringing a message before a widespread public. Papers, discussions and brains trusts serve the triple purpose of educating those attending the conferences, supplying them with information to pass on to their colleagues and friends, and obtaining press and wireless publicity. It is usually possible, moreover, to make such conferences financially self-supporting.

News Reels

Occasionally events occur, as for example the opening of a new plant, which have an interest to the producers of news-reels and news magazines. As these are shown to millions of people in a single week, they are of great propaganda value. The cost of arranging them can be included in those of the press department.

Film and Film Strips

(*a*) *Production.* There is an increasing tendency to use films and film strips for educational and informative purposes. Generally speaking documentary films, as distinct from entertainment films, do not find their way into the ordinary cinemas. The most usual channel is non-theatrical distribution to schools, colleges, clubs, associations, churches, etc., where there is an enormous demand.

To do the job properly it is desirable to produce one half-hour film and three

or four short films a year, the longer film costing about £7,000 and the short films £2,000 each, or, say, a production programme of about £15,000 a year.

In addition, there is a widespread demand for film strips and slides especially in schools and colleges. A reasonable series of film strips and slides, with speakers' notes, would cost another £2,000 a year.

On similar lines, it is often desirable to supply recorded talks for those occasions where it is not convenient for a lecturer to travel to the association concerned. The cost is small, say £500 a year.

(*b*) *Distribution.* It is not sufficient, of course, only to produce films and film strips, slides and records. That is only half the task. A central library has to be established, from which the films may be forwarded to all interested groups. Then, mobile projectors with trained staff, will have to be made available in different parts of the country to give shows to existing and to invited audiences. The cost of a country-wide distribution service would be at least £25,000 a year.

Photographs

A library of photographs of suitable subjects is always valuable for exhibitions, for illustrations for articles in the press, and for the use of free lance journalists. The cost of taking the photographs, prints, and indexing, with staff, would be about £2,500 a year.

Exhibitions

During and since the war exhibitions have become increasingly popular, and numerous. It is possible, in the space of two or three weeks, by means of a first rate stand, to impress a message on the minds of a million people. But the cost of a first rate stand at an exhibition like the Ideal Homes in London can be as much as £10,000. The smallest and least conspicuous space costs £500. To take reasonable space in the leading national and provincial exhibitions calls for an allocation of £30,000 a year.

Travelling exhibitions, either self-contained in the form of specially equipped vans, or else carried in vans for erecting in suitable halls, are useful for taking the message to the smaller towns and villages. Ten such exhibitions are needed, costing some £10,000, and the running costs, including suitable staff, amount to £5,000 a year.

Displays

There are many opportunities for the use of displays, in local exhibitions, in processions, in civic weeks, etc. Apart from complete displays, there are calls for models, posters, wall sheets, diagrams, etc. to fit in to other schemes and lay-outs. All these have to be made available at convenient centres. Assuming a hundred displays and models, at £30 each, two thousand double crown posters at 2/- each, 20,000 wall sheets and diagrams, at 4/- each, and 100,000 hand-out leaflets at £3 a thousand, the cost, including carriage and maintenance, would be about £8,000 a year.

Information

A central information bureau is essential. It must be well equipped with a library, photographs, statistics and technical data. A lecture hall and film theatre are desirable, but not essential, additions. Excluding these, the cost of the bureau, taking into account rent, rates and staff, is not less than £3,000 a year.

Contacts

To make sure that policy and development are properly understood, either the chief officer or a public relations officer must spend considerable time establishing personal and friendly relations with the leaders of public opinion, and ascertaining their views and criticisms. This involves continuous contact at meetings, receptions, lunches, dinners, etc., with cabinet ministers, prominent members of both Houses of Parliament, senior officials of Government Departments, lobby correspondents, newspaper proprietors, editors and publishers, authors, free-lance journalists, B.B.C. executives, film producers, industrial and commercial leaders, prominent planners,

architects, builders, engineers, surveyors, doctors and many others. These personal contacts must be supplemented and strengthened by wide reading of the press, the professional, technical and trade journals, and by obtaining membership of the associations, societies and clubs in which the leaders of public opinion are interested. These activities involve expenses and entertainment, running up to £1,000 a year.

Opinion Research

To make sure that propaganda is achieving the desired results, a periodic survey of public opinion should be taken in conjunction with a research organisation. This would cost £1,000 a year.

Summary

The total of all these methods of education and research is over £500,000 a year—a sum which is, of course, quite outside the scope of the N.S.A.S. As you know, the amount spent last year on propaganda was about £1,000. The results achieved in the last few years with such tiny means are quite amazing. But we shall have to expand our propaganda very considerably if we are to achieve our aims within our lifetime.

Liaison

One way of reinforcing propaganda is to make full use of natural allies. Every propaganda movement has a number of potential allies, and liaison can be made on the lines of joint or co-ordinated efforts. In the case of this Society, the allies are numerous, including the Solid Smokeless Fuel, Gas and Electricity industries, several Government Departments, such as the Department of Scientific and Industrial Research, the Ministry of Fuel and Power, the Ministry of Health and the Ministry of Town and Country Planning, and a number of national organizations concerned with fuel, health and amenities. Every effort must be made to get their assistance in all fields of propaganda.

I will now run through the various propaganda methods again and set down my estimates of the minimum sums necessary to achieve smoke abolition in, say, the next twenty years.

Advertising. I think we must forget all forms of advertising. Unless it is carried out continuously and on a large scale, money spent on advertising is mainly wasted, and continuous large scale advertising is quite beyond the Society's means.

Publications. The Society is already producing " Smokeless Air," an admirable quarterly, whose circulation should be increased in size and frequency of issue as soon as possible. We also have Mr. Marsh's excellent book " Smoke." I feel that we ought to extend our range of publications, to include leaflets, pamphlets, and papers, up to an expenditure of £5,000 a year.

Press. The press is likely to be our most fruitful field, and I consider that we should build up our press department as rapidly as possible to a limit of £5,000 a year.

B.B.C. The press department will be able to keep in constant touch with the B.B.C., supplying news items and scripts. No extra cost is involved.

Platform Publicity. As the Society has enthusiastic members all over the country, we should be able to rely on voluntary efforts for speeches and lectures. Conferences must be made self-supporting.

News Reels. Here again the press department will make arrangements for suitable inclusions, without cost to the Society.

Films and Film Strips. The production and distribution of films is quite beyond the Society's means. Film strips and recorded talks, however, are much less expensive, and, in view of the importance of pressing home our story in schools and colleges, I feel that we ought to spend £2,000 a year on them.

Photographs. We must depend mainly for the time being on voluntary efforts, supplemented by a few purchased from the agencies, spending, say, £100 a year.

Exhibitions. We cannot afford to take space in the main national and

provincial exhibitions, or to equip and run the expensive travelling exhibitions. Our efforts must be confined to displays.

Displays. We can obtain valuable publicity by supplying attractive and colourful display units, models, posters, wall sheets, diagrams, etc., for use in local exhibitions, civic weeks, festivals, and similar functions. As these suffer badly during transport, it will be advisable to have provincial storage centres. I recommend an annual expenditure of £4,000 under this heading.

Information. It is most important that we should run an efficient and well equipped information bureau, able to supply literature, photographs, statistics and technical data to all enquirers. It would be difficult to do this for less than £2,500 a year.

Contacts. Personal contacts at high level are likely to be of growing importance in the future, and I consider £1,000 a year would be well spent on this activity.

Opinion Research. We must be content with the findings of our own members for the time being.

Recommended Annual Expenditure

The total of these recommendations is £19,600, or, say, £20,000 a year. Such expenditure on propaganda, while it would not achieve spectacular results in a short period, should nevertheless go a long way towards achieving the abolition of smoke within the lifetime of many of us.

Discussion on Mr. Hardern's Paper

John Roberts (Cheltenham) took the opportunity to pay tribute to the excellent work done by the N.S.A.S. Of all the organizations with which he had been associated over a long period of years, he knew of none that could be recommended to spend its resources so wisely and to such good purpose as the N.S.A.S.

He recommended that the Council should prepare a case to put up to the Ministry of Health in support of a grant to continue the good work.

W. Beaumont (Chief Sanitary Inspector, Coventry) referring to the total costs of £500,000 a year being the estimated amount necessary for putting into effect all the methods of education and research suggested by the author, asked " where is the money to come from ? "

He maintained that the question of atmospheric pollution was a national problem and therefore greater financial support should be given by the Government to the Society and also to local authorities. That the Society should be appointed as a " Board of Control " vested with powers to advise and if necessary, to direct local authorities upon the question of atmospheric pollution. Only in this way would it be possible to secure uniformity and concerted action. Local authorities should be reimbursed to the extent of 50 per cent. of the cost of carrying out the work under the direction of the controlling body. He said that in his opinion the existing machinery for dealing with the problem of atmospheric pollution was most inadequate and inefficient. The work required accelerating by means of increased financial backing and greater control.

F. V. A. Smith (Chief Sanitary Inspector, Burton-on-Trent) said that his Authority were shortly holding a municipal exhibition and in his search for exhibits he was very surprised to find how few illustrations were available in connection with the work of atmospheric pollution.

He suggested that the Society appoint a panel of experts to consider the possibility of producing suitable photographs, films and film strip to help make the public smoke-conscious.

Alderman W. K. Heaton (Bury) congratulated the author on the amount of detail contained in the paper, but could not agree with the recommendation to spend £20,000 annually for a

period of ten years. He pointed out that while there were about 1,500 authorities in the country, only about 400 were affiliated to the Society. So far as Bury was concerned he could not pledge his Authority to such a scheme. Alderman Heaton drew attention to the fact that it had been stated earlier in the Conference that probably there would be a financial grant from the Ministry of Fuel and Power, but he noticed that when the Minister of that Department addressed the Conference the previous day he had made no reference to such a grant. Personally he was not surprised at this omission, as in his opinion no Government Department would subscribe to such an amount as had been mentioned without having control of the spending of any grants made.

Alderman Heaton went on to say that he felt this question was one for the Minister of Health who should give Local Authorities powers to deal with the problem. His Authority had applied to the Ministry for such powers in byelaws some months ago and the Ministry did not grant the making of the Byelaw required, to deal with the problem. Surely with the putting into operation of the National Health Act, the first essential to good health was a clean and unpolluted atmosphere, and unless Local Authorities had the powers in this direction, then the population was not likely to reap the full benefits of such an Act.

Arnold Marsh (General Secretary) said that he welcomed Mr. Hardern's paper very much indeed. He had now been for many years engaged in the task of trying to secure for the Society the maximum of publicity that was possible with the extremely small resources available, and he was grateful for the most convincing way Mr. Hardern had stressed the need for the planned selection of activities. Concentration of attack on the most favourable targets was essential, and the danger always to be guarded against was that of dispersing one's offensive power over so wide a front that it was everywhere weak and ineffective.

A scientific approach to the problem of propaganda with limited means was necessary: that meant experimenting and carefully observing the results of the experiments, and in fact of all their propaganda work, so that effort could be directed more and more on the projects that gave the best returns with the least outlay of money and time.

Replying to the criticism of Mr. Smith of Burton-on-Trent about the small amount of photographic and exhibition material available, Mr. Marsh said that exhibits were being built up as quickly as the time that could be allocated to this work would allow, and that many new photographs were becoming available as the result of an appeal by the Society published in the photographic press during the summer. A great deal of correspondence and other work was involved in such schemes, and had to be subordinated to conference and other urgent business. Requests for the loan of exhibition material were continually being received from local authorities and others, and it was unfortunate that so many came at the same time.

SMOKE PREVENTION IN RELATION TO TOWN PLANNING

by J. NELSON MEREDITH, F.R.I.B.A.,
City Architect, Bristol

"A spotless town is a more moral town than an air-polluted town. It is hard to have clean children in a dirty town, and physical dirt is closely related to moral dirt, and both lead to degeneracy. It is too much to expect good results in schools that exist in an air-polluted atmosphere. We cannot imbue the young with a sense of beauty when beauty itself is bedaubed."

—*Dr. Evans, Chicago.*

IN this paper I speak solely as an Architect, and I make it plain at the outset that I do not in any way profess to be able to express an opinion from a medical or health point of view, except to say that it is manifest to everyone that smoke cannot be anything but injurious to health, this being borne out by the fact that deaths from pulmonary complaints and the Infant Death Rate are much higher in built-up Industrial Areas than in the Country Areas.

An important point to remember is that each year three million tons of solid matter are thrown into the air together with about five million tons of sulphur dioxide (which is equivalent to about eight million tons of sulphuric acid) from the industrial and domestic chimneys in this country, and further, some thirty odd years ago, it was calculated that six million tons worth of fuel was wasted in England on the production of useless smoke. This was a mere waste of coal and in addition, we must allow for the cost of extra washing which smoke causes in every household, the damage to agriculture, buildings, and last but by no means least, health. Obviously a smoky town cannot be a clean town and when we realize that over every square mile of our industrial towns anything from 200 to 500 tons of smoke dirt falls each year with various corrosive acids and vapours in addition, it is obvious that unless action is taken to prevent this menace, all our Planning Schemes will be to a great extent in vain.

Breathing being a continuous process, it is well to remember that the body takes in about 3,000 gallons or 35 lbs. of air each day, seven times the average amount of food and drink.

No doubt you will expect me as an Architect to be expressly concerned about the disastrous effect of smoke upon buildings; and as buildings will form the major part of our Town Planning Schemes it is from this aspect I offer my comments.

Coal, I believe, has been in use since about 1500 B.C. and for some seven hundred years complaints have been put forward. In the 13th century we are told that Queen Eleanor when staying at Nottingham was unable to remain in the city owing to the smoke nuisance and moved to Tutbury, and at the end of this same century, certain important people complained of smoke in the London area.

In the 16th century, Queen Elizabeth complained of smoke in the Westminster area with a result that certain industrial concerns turned over to wood. Later we hear of complaints by Charles II and we read that in the 17th century John Evelyn wrote, referring to London — "That this glorious and ancient city should so wrap her stately head in clowds of smoake and sulphur so full of stink

and darkness, I deplore with just indignation."

Sunlight, as we all know, aids the general resistance to disease and is one of the essentials of animal and vegetable life—obstruct it by smoke and the result is obvious.

Let us not forget these points and endeavour to realize the vital task which lies before us.

The Need for Vision

Town Planning cannot possibly be carried out without *vision*, and when we plan either the most meagre dwelling or a Civic Centre, we visualize the final achievement and suggest various materials accordingly. In other words, we visualize the finished product. Yet in how many of our building works of the past has this been materialized? Look at the Town Halls in Manchester and Birkenhead, once cheerful and bright buildings, now covered in a shroud. Surely when the Architects designed these they did not anticipate these black masses? Look at St. George's Hall in Liverpool, once a beautiful light brown colour, now a dark mass having lost practically all resemblance of the beauty of Darly Dale Stone. Would Elms and Cockerell now find it difficult to recognize their great conception? I believe they would.

Fortunately under the 1947 Town and Country Planning Act, Local Authorities have executive powers by means of which conditions can be attached to their consent to proposed industrial and other building development of the land specified in the Act. They can when dealing with proposed developments that include fuel burning installations require the use of methods which are as smokeless as practicable and can attach suitable conditions for this purpose to their consent.

Incidentally, I trust that other Local Authorities will follow the examples set by the City of London and Manchester Corporation, who, in their lease agreements for industrial areas have excellent clauses as to the construction of furnaces and alterations to furnace equipment, etc.

In the Housing Manual, 1944, the Ministry of Health state :— " The Government and the Industries concerned are alive to the need for developing domestic fuel appliances and installations designed to give greater efficiency and reduce the emission of smoke. Recently both together and separately they have sponsored an increasing volume of research towards this end. There is now a widespread demand that the evil of atmospheric pollution shall be resolutely attacked, one of its principal causes being the inefficient combustion of raw bituminous coal in the home. The Government attach particular importance to smoke abatement in view of the injuries to health and to general amenity caused by atmospheric pollution. The extra labour of the housewife is another evil result which must not be overlooked."

In our post-war Reconstruction Schemes a series of opportunities will occur for making the " resolute attack " recommended both over the whole field of Industry and to a very large extent in Housing. Measures can be taken to ensure that new fuel burning installations for industry and commercial heating are both efficient for their purpose and such as can be operated with maximum smokelessness. Complete freedom from smoke emission in new houses may not be immediately possible but the Housing Manual recommends that open fires installed should be suitable for burning smokeless fuel as well as bituminous coal. Steps have already been taken in Bristol to this end.

Any town could and should be a pleasant place in which to live, yet few of our towns ever approach those standards of amenity that makes people consciously regard them as pleasant places in which it is a privilege to work and live. It appears that many are simply places to work in and then to escape from.

We grumble about the vast sprawl that has taken place in our large towns but can we wonder at this when we realize that the simple needs of our people, i.e., healthy air and sunshine for the children, clean surroundings to

give a clean home and less household labour, a garden where the grass is green and flowers will flourish, are non-existent ?

I firmly believe that the æsthetic sense of the town dweller has been blunted by his environment or has perhaps never been given the opportunity to develop. Drab surroundings, dimmed sunshine, the shroud of dirt over everything, the loss of colour, all these mean lower standards and weakness of effort that is needed to remove them. Small wonder that we see cheap and tawdry substitutes for the beautiful.

To combat this great enemy, Smoke, I believe we should begin with the young people in our schools. Young minds are very receptive and if those responsible for the education of our children endeavour to instil into these young minds what harm can be done by smoke and what really does make a city or town a pleasant place in which to live and work, I feel we could look forward to a happier and healthier existence.

Incidentally, we must not forget that in a smoke laden atmosphere, the health of children is particularly affected. The ceaseless fall of smoke dirt degrades environment, robs our towns of much of the amenities they might enjoy and is one of the principal causes of Urban squalor. Reconstruction and Town Planning measures that fail to take this factor into account can never fully achieve their goal. Smoke dirt corrodes, soils or destroys stonework, fabrics, metal and paint. Everywhere money and labour is diverted from productive tasks to repair or prevent the ravages of smoke, and I understand that over the year, wastage is measured in millions of pounds.

Plant life suffers as does human life. In many areas beauty and solace of flowers and greenery is next to impossible or is won only by costly effort.

I have mentioned earlier John Evelyn and from his day in the reign of Charles II to the present day people have been trying to solve this problem. I feel, however, that the attempts made have failed because of the over-riding need to burn coal without regard to the consequences. Nevertheless, in the last two generations much has been done and here I pay tribute to the National Smoke Abatement Society. It is, I feel, the bounden duty of us all to do everything we possibly can to support the Society in their great work.

Smoke is formed by the imperfect combustion of raw bituminous coal. It can be prevented either by burning raw coal only under such control and in such suitable appliances that by ensuring perfect combustion no smoke is formed, or by first pre-treating the coal to give fuels that are smokeless under all conditions and utilize the smoke-producing constituents as materials (and they are very valuable materials) for productive purposes.

Smoke prevention is one important reason for securing a better and more scientific utilization of our coal reserves.

Central Areas

In our reconstruction schemes, central areas will in the main be the first to be dealt with. Therefore, the first part of any town or city to be made a smokeless zone will normally be the central area. These are particularly suitable for a number of reasons. They consist mainly of business and administrative premises, shops, theatres, etc., all of which from the nature of their heating requirements can be made smokeless with little difficulty and economically. The central area is, or at any rate should be, the most important part of any town. A city or town is judged by its own citizens and by its visitors by the standard revealed at the centre ; in short, it is the heart of the city or town. Therefore, the new buildings to be erected in the central areas should be smokeless themselves and should not be forced to suffer rapid degradation by blackening and corrosion because of smoke emitting neighbours. Manifestly it is bad planning to strive for beauty and amenity in the centre of our towns without at the same time doing our best to give the reconstructed areas an atmosphere in which it is possible for these beauties and amenities to be

retained, mellowed and enhanced rather than degraded by the advancing years.

Central areas should contain, and more are more likely to contain, parks, gardens, and tree-lined streets or boulevards. Here again a smokeless atmosphere is necessary if grass, trees and shrubs are to thrive and if they are to give pleasure rather than by their dinginess depress us.

Colour and brightness are needed if the centre is to be a place of charm and achieve dignity with gaiety.

The District Heating Scheme prepaired by Messrs. Arthur Scull & Son Ltd., a Bristol firm of engineers, for the central portion of the city, is certainly a means of achieving a Smokeless Zone.

The Disfigurement of Stone

The most obvious and familiar effect of smoke on buildings, stone and brick (and I would add, statues), is the disfigurement due to the blackening of the surface and the encrustations of sooty matter that frequently obliterate essential lines and decorations. Such disfigurement does not in itself injure the stone and does not cause material loss. It does, however, seriously reduce the æsthetic and decorative value of a building and from that point of view, soot and tar may be said to have a destructive effect.

The material effect is caused by the corrosive action of the sulphuric acid contained in the deposit, and that brought into contact by air, rainwater or condensed moisture is the most serious economic factor.

Here I must emphasize the fact that atmospheric pollution is by no means the only cause of decay ; as a matter of fact it has too often been blamed for decay that can be traced to some quite different cause. A very common cause is contamination of the stone by soluble salts other than those produced by chemical reaction with atmospheric gases. The cause can, however, be largely avoided in new buildings by the exercise of suitable precautions by the quarry owner, the builder and the architect. Occasionally, though rarely, and then generally by mischance, the salts are present in the stone before it is placed in position. Usually, however, they are absorbed from an external source, from the soil or from neighbouring materials in the building such as mortar or brick and concrete backing or they may be the result of the mistaken use of water soluble materials for purposes of cleaning and preserving. Nevertheless,. chemical analysis will reveal what salts are present and suitable investigation will often give some indication of their origin. As a rough guide for distinguishing between effects of atmospheric pollution and those to salts contamination from some other source, it may be stated that except with magnesian limestone, the appearance of efflorescent salts on the surface of the stone indicates that the decay is to be attributed to some cause other than or in addition to atmospheric pollution.

Decay of Limestone

Incidentally, limestones are the ones principally affected. These stones, of which the principal constituent is calcium carbonate, reacts with sulphuric acid to form calcium sulphate. Erosion is assisted by the fact that calcium sulphate occupies a larger volume than the carbonate from which it is formed and is rather more soluble in water than the carbonate. One of the effects of the reaction is the formation of a hard impermeable skin on the surface of the stone which tends to blister. An ugly form of decay is thus set up. The formation of the sulphate skin is inhibited in exposed positions where the surface is frequently washed by rainwater. In sheltered parts the surface gradually blackens and thus is developed the familiar black and white effect seen in so many of the Portland stone buildings in our cities to-day.

There is some difference of opinion as to the æsthetic effect of soot on limestone buildings. Only recently when discussing with an architect friend some buildings in Bath, he was very definitely of the opinion that these buildings would be by no means enhanced were the discolouration removed. Present day conditions are such that it is unusual to see in this

country any but the newest town buildings in a clean condition, so that soot has come to be regarded as artistically desirable, but it cannot be denied that its effects are often unpleasant and on architectural sculpture often ludicrous. From the technical point of view, soot deposition is harmful rather than protective and for this reason, if for no other, is undesirable.

Slate

Slate is another building material which is attacked by atmospheric gases, and as Sir Frank Baines has said, "Even the Westmorland slates which used to be regarded by architects as the best for roofing, and as an almost permanent material, have been so attacked by atmospheric pollution that the finger can be driven clean through them without any material resistance." Decay usually manifests itself on the underside, especially between the laps where water is held in contact with the slate by capillary attraction.

Sandstones are not so readily affected except when they contain a calcite cementing material. This reacts with sulphuric acid with the result that silica sand grains become loose and the stone breaks down and disintegrates.

Reconstructed stone which is usually manufactured from crushed natural stone and Portland cement, behaves in much the same way as natural stone. Surface erosion and skin formation occurs. In general the material has not yet been used sufficiently long for the more spectacular effects of atmospheric pollution to show themselves, although instances are known where flaking is occurring in much the same manner as with natural limestone.

Mortar may be severely affected, largely because of its porous structure and the fact that it is undergoing chemical changes for a considerable time after it has been placed in a wall.

Brick is to some extent attacked and particular decay has been noted where it has been used in conjunction with limestone. The sulphates from the decay of the latter have penetrated the surface of the brick and by crystallization and expansion have loosened the surface. Except where this absorption and penetration takes place, no other deleterious effects are attributable to atmospheric pollution.

The Houses of Parliament

A noteworthy case of decay to stonework due to defect in the original rock is that to the Houses of Parliament. The building was begun in 1840 and completed in 1852. Evidence of decay was apparent before the building was completed and by 1861 an Expert Committee was appointed to examine the problem and to suggest the best means of preserving the stone. Since then decay has continued and extensive repairs and replacements have had to be undertaken, costing several hundred thousand pounds. The primary causes of the decay were the use of a magnesian limestone, unsuitable for the decorations it had to carry and *faulty bedding* of some of the stone. Furthermore, another cause of the trouble was the use of iron dowels and tie rods which naturally rusted. Obviously these should never have been used.

I myself have experienced trouble due to faulty bedding of stone and here I should like to stress the extreme importance of the laying of masonry on its natural bed.

Incidentally, in a recent case in Bristol where I was anxious to preserve the façade of a building of historical and architectural interest, I found on inspection that in addition to decay caused by atmospheric pollution, a large number of stones were fractured due to the use of iron cramps, with the result that preservation was impracticable.

With regard to remedies, I must emphasize that until pollution of the atmosphere by smoke and acid gasses is regarded in the same light as pollution of water supplies and treated accordingly, disfiguration and decay of building stone due to this cause will necessarily continue. Suitable choice and use of material is to a certain extent a safeguard against decay but is of course little safeguard against discolouration by soot. Indeed those building stones that suffer most seriously

in this respect are amongst the most durable. Surface treatments designed to confer weather resistance are seldom helpful. In special circumstances where the treated stone can be kept under observation and where the treatment can be renewed from time to time as may be necessary, a suitable selected stone preservative can occasionally find useful application. General and indiscriminate use is not to be recommended. I admit that oil paint applied when the stone is dry and renewed every few years has good protective qualities, but I have seen many excellent examples of stonework and stone carving spoiled by the use of oil paint. Paint is of course not suitable for the treatment of buildings of historic and archæological importance. Limestone buildings can be maintained in a clean condition by hosing them down with water at intervals.

The inhibition of skin formation and the removal of decomposition products should also enhance durability. The Goldsmiths' Hall in London has for a long period been washed in this way twice a year, with excellent results and certain other buildings are now being maintained in the same way. Whether this method would be equally effective if applied to sandstone buildings is doubtful. Some types of sandstone may benefit more than others.

To regain a good appearance in old buildings that have been allowed to become very dirty, more elaborate methods are needed. Only water or steam should be used. Chemical cleaning agents which are liable to leave soluble salts in the pores and to cause subsequent decay should always be avoided, however attractive they may appear to be either in effectiveness or in relative cost.

It is, of course, manifest that purification of the air would contribute to improve the appearance of buildings and to extend the useful life of the materials employed in their construction.

Prevention however is better than cure so let us all strive for clean air to which smoke is the enemy.

I therefore recommend the installation of District and Block Heating Schemes, and in the hope that gas and electricity might possibly be distributed at a cheaper rate, more use be made of these in industrial, commercial and domestic heating (and I would add railway engines under electricity), open fires suitable for burning smokeless fuel, new fuel burning installations both efficient and such as can be operated with maximum smokelessness, and, this is important, to do all within human power to arouse the interest of the general public. Here I feel sure the Press and the B.B.C. could be most valuable agents and would it not be beneficial if the post offices franked all letter stamps with the slogan " Unholy Smoke " ?

Town Planning affects every individual in the country, so it behoves everyone to strive for the prevention of smoke.

Let it be said by those who will come after us—they did a magnificent job when they used their common sense and took action to control smoke.

In conclusion, I offer my grateful acknowledgements to :

The National Smoke Abatement Society for the valuable literature it has prepared and distributed ; Mr. Arnold Marsh, its General Secretary and Editor, whose book " Smoke : The Problems of Coal and the Atmosphere " is a veritable mine of information, and Mr. R. J. Schaffer (Building Research Station) whose report on Atmospheric Pollution in its bearing on the weathering of stone and similar building materials is most enlightening.

Discussion on Mr. Meredith's Paper

Alderman J. J. Milton (Chairman, Bristol Health Committee) said that he had come to take part in the discussion to endeavour to get the Conference to take a more optimistic view of the Society's work. Some said they had no smoke problem; others asked the Society's help because they had apparently achieved little.

In the first place they all had the smoke problem. It was a national problem and affected them all because it was a health matter and smoke had no barriers or boundaries. Secondly, in re-planning house erection, alteration of industrial power plant, or in fuel saving, all the interested sections were seeking advice and installing plant or equipment that would abate smoke and reduce fuel consumption.

The Society had achieved much and had built better than many seemed to think or know, and evidence was shown by the speaker, who was an architect of some repute, coming to take part in the conference. He congratulated him on his Paper and trusted that Conference would take a more optimistic and positive view and go forward to achieve much more.

Sir George Elliston (Past President) said he had hoped to hear more from Mr. Meredith about the development of district heating schemes. The present was a unique opportunity to adopt such schemes, especially when rebuilding the business quarters of large cities now in a state of devastation. The opportunity was equally tempting in connection with the development of housing estates, and it was disappointing that so many local authorities were "missing the bus." Surely district heating should be a central feature in any proposals for the betterment of housing conditions. Something like a revolution was being achieved in raising the standard of living for the working classes, and the comfort of their homes would be enormously enhanced if heating was supplied from district stations. By that means every room in their houses would become a sitting room. The young people now prolonging their school days would be able to do their home work away from the wireless and other distractions of family life, and it would no longer be necessary for the old folks to go to the "pictures" when they wanted to keep warm. Sir George added that he hoped the councillors and officials attending that conference would keep the subject of district heating before their councils on every appropriate occasion.

W. L. Mather said that members of the Conference were probably able to do more through their membership of the Smoke Abatement Society to the general good of the country than by any other means, since by the removal of atmospheric pollution they would improve health and amenities for the whole nation. He felt that in addition to the public efforts which the delegates were making, that each one in his or her individual capacity should try, before the next Conference, to make some positive contribution to smoke reduction. He suggested that as a target each member present should aim at reducing the smoke from at least one chimney during the forthcoming twelve months.

G. H. Wilkinson (Sanitary Inspector, Corby U.D.C.) asked whether only a few architects were interested in this subject; and whether the subject was included in the syllabus for architectural students.

He instanced Corby, a town commenced only in 1933. The layout of the estates (built by the steel firm) with variation in houses, its avenues, groves and closes, showed that the architect employed was an expert. But the town had been built on the windward side of

the works; and what was more serious —the boundary of one estate was within 80 yards of a batch of blast furnaces!

Councillor J. S. Tennant (Chairman, Health Committee, Harrogate) said that as half the problem was caused by domestic smoke, he felt that propaganda should be used in advising on economical firing of open fires. Also in the old type of houses, the provision of modern grates which give a better combustion of coal; and landlords should be allowed to count such installations as structural improvements.

He urged delegates from the so-called "smoke free" areas to go back to their Councils and report that scientific investigation showed that the evils of smoke deposits were carried in varying degree over the whole country, and it was in the national interest to take united action to overcome the smoke menace.

A. E. Snodgrass (Chief Sanitary Inspector, Bury) asked if the promoters of private Acts which contained provisions relative to the establishment of smokeless zones had fully considered the significance of the words "so far as practicable" in relation to the installation of furnaces capable of being operated without emitting smoke. He enumerated some of the practical difficulties in dealing with the emission of smoke from chimneys under Section 101 of the Public Health Act, 1936, which contained a similar saving clause. He also asked how local authorities taking legal proceedings in respect of a smoke nuisance from a plant which had received "prior approval," proposed to deal with the defence that the plant had been approved by the local authority, assuming such nuisance did not arise from inferior fuel, bad firing or obvious mechanical defect.

Dr. C. F. White (Medical Officer of Health, City of London) said that, in listening to Mr. Hardern's paper on Education and Propaganda followed by Mr. Meredith's paper on Smoke Prevention in Relation to Town Planning, it had occurred to him that there should be some means by which the members of the staffs of local authorities and also the general public should be able to see the whole picture of smoke abatement as well as of other local government problems in their particular areas. So far as he was aware the Medical Officer of Health was the only officer who had to submit an annual report to his Authority, copies of which had to be sent to the Ministry of Health, and were also available to the press. He had noticed that for the first time this year the annual report of the Ministry of Health and the annual report of the Chief Medical Officer had been printed in one blue book. Would it not be a good idea if every local authority had to issue an annual report which would comprise sections by the officers in charge of all the various departments? It would be important that each should write a brief critical survey of the work of his department during the year; statistical tables being printed as appendices. In his experience very few people read statistical tables, but they would read written reports provided they were not too technical. Annual reports of the work of local authorities on these lines would correlate the work of the various departments and would be a valuable and inexpensive means of education and propaganda. The local press would certainly make a feature of extracts from the report and the technical press would give wide publicity to points of special interest.

John Roberts (Cheltenham) said that it appeared to him that during much of the work of the Conference, we were preaching to the converted. He suggested that at future Conferences other institutions, such as the Iron and Steel Institute, the Institution of Mining and Metallurgy, and the Coke Oven Managers' Association should be officially invited to attend. Both sides should benefit from the free exchange of views.

Referring to a previous speaker's remarks on Nottingham, he said that Mr. Meredith's reference to Queen Eleanor was a well-known historical fact. (It occurred in the year 1257, when Henry III invaded Wales, and left his wife at Nottingham).

Charles Gandy (Chairman of Execu-

tive Council) reminded the Conference that the town planning of a city now dealt with the city as a whole, and that in nearly every case the plans which had been prepared in recent years assumed that by the time the plan took full effect the whole city would be a smokeless one. In the meantime, unfortunately, it must be regarded as certain that there would be large residential areas which would not benefit by the installation of the new appliances in housing estates, and where houses especially in poorer quarters often covering many hundred acres of land were still equipped with old-fashioned grates. These, besides being extremely wasteful of fuel, were the chief source of domestic smoke pollution, so degrading to the health, happiness and amenity of the neighbourhoods in which it was produced. He asked that every delegate and member of the Society should do whatever he or she could to ensure that this aspect of the problem was fully considered, and if possible some solution found for it.

F. J. Forty (City Engineer, City of London) in a written contribution said that at this meeting to discuss ways and means to further a cause which all delegates had at heart, and in the midst of speeches of familiar type — the question presented itself—had any practical progress really been made since they met in a state of similar enthusiasm last year? Are they in their respective spheres able to report some real advance towards the desired end by their own local authority?

One delegate that morning had suggested that there was a waning of enthusiasm and active disposition on the part of the delegates in the Conference proceedings that week. The time available for discussion did not allow for any extensive comment, but reflection upon what this member said caused him to feel that something more than the district Progress Reports already presented to the Conference might be helpful.

He served the Corporation of the City of London, a Local Authority from whose ranks came the Society's President for the past two years, Sir George Elliston, whose enthusiasm in the case of smoke abatement is so well known as not to require emphasis, and whose Medical Officer of Health, Dr. C. F. White, ever-active in the cause of smoke abatement, had addressed them that day.

The contribution of the Corporation to the cause of smoke abatement had been positive and continuous. In the City of London Various Powers Act, 1946, power to make bye-laws was secured, and drafts of those bye-laws had been submitted to the Ministry of Health with all possible representation, to ensure that they would soon be operative. Primarily, the purpose of the bye-laws was to ensure that the heating arrangements in new buildings and in substantially altered buildings, required the prior approval of the Corporation; the Corporation in considering applications would have to be satisfied that the proposed heating arrangements were calculated to prevent or reduce to a minimum the emission of visible smoke. It should be noted, however, that the Corporation of London had not simply rested content with making bye-laws to be complied with by others; it was taking active steps to deal with certain of its own property.

In the artisan's dwellings of the Corporation, erected towards the end of the last century, the domestic stoves of an old fashioned type were to be replaced by appliances of the latest type fully in compliance with the projected bye-laws, and suitable to burn smokeless fuel when this became available.

What else had the City of London done? The answer to that might readily be given by a reference to the investigation into the possibility of the application of district heating to the City of London. The Corporation ordered, and had received, a report from its engineering consultant, Mr. S. B. Donkin, upon the possibilities of that exceedingly important matter. No final decision upon that report had yet been taken, because since it was made there had been certain events to take into consideration, but as soon as the Corporation were in a position to

do so, they would, in conjunction with the Town Planning Authority, which, under the new Act of Parliament, 1947, was the London County Council, arrive at a decision on the scheme, which, needless to say, was of a very considerable magnitude. It was not for him, at the present time, to attempt to forecast what this decision would be, but it was, he thought, sufficient for the present purposes, to show how deeply these matters were being gone into with a view to making every possible contribution to improve the amenities of those parts of London for which the Corporation were responsible. It would probably be realized that the ancient City of London was well to the fore in an examination of modern problems.

THE BRAINS TRUST

THE final session of the Conference took the form of a Brains Trust on " Smoke Prevention and Clean Air," to which the public was invited. The report that follows includes all the questions asked and the main points of the replies.

Mr. Stewart Swift (Chief Sanitary Inspector, Oxford), Question Master, opened the proceedings by welcoming the visitors and the parties from colleges and schools who were present. He then introduced the members of the Trust, as follows :

Mrs. Helen Brown, of Oxford, who was a representative on the Society's Council of the Women's Advisory Council for Solid Fuel and an expert on the use of fuel and fuel-burning equipment in the home.

Mr. S. N. Duguid, who was well-known as a fuel technologist, lecturer, organizer of lectures, and active in many other ways on the industrial side of the problem. He had been of great help to the Ministry of Fuel and Power in its educational work and was a member of the Society's Council and Technical Committee.

Dr. Perry, deputy Medical Officer of Health for Cheltenham, who they were very glad to have with them, and who had most kindly agreed at short notice to take the place of Dr. Morley, the Medical Officer of Health, whose absence through illness was greatly regretted.

Mr. F. J. Redstone, the Chief Sanitary Inspector for Bristol and Honorary Secretary of the Bristol and District Regional Smoke Abatement Committee. Mr. Redstone, who was Chairman of the Society's Publicity Committee, hardly needed an introduction at a Conference of the Society.

Mr. John Roberts, who was a leading authority on coal and its carbonization, and who was fortunate enough to live in Cheltenham, where he was associated with the Severn Valley Gas Corporation.

Mr. R. W. Steel, who had been closely associated with the Electricity Undertaking in Cheltenham, and who was now Commercial Manager to the South-Eastern Electricity Board.

Mr. Swift thought they had assembled an extremely well-informed team, who between them so well covered the many aspects of the smoke problem that they should have little difficulty in answering any of the questions. He then read the first question.

Does the Brains Trust think that more frequent prosecutions under the Public Health Acts would cause manufacturers to sit up and do more than they are doing to prevent smoke—or do they think a better policy is persuasion and advice ?

Mr. Redstone considered that it was not advisable to institute too many prosecutions because manufacturers were doing their best with obsolete plant and poor quality fuel. More could be done with the kid glove than the crowbar and it was better to go along to the works to discuss it with the managements and other experts without taking it before the magistrate.

Would the Brains Trust explain the

difference between smoke from factory chimneys and that from domestic grates?

Mr. Duguid said that the main difference was that the smoke from domestic chimneys was more harmful.

Mr. Steel added that as the smoke from domestic chimneys came from so many different points, little could be done, but that steps could be taken to deal with the smoke and grit from factory chimneys.

Dr. Perry said that cancer was worse in smoky areas than in clear areas, and it was possible that cancer of the lungs was caused by the tarry matter in domestic smoke.

Mr. Roberts concluded by saying that the domestic fire burns at a lower temperature for a longer period and therefore produced more smoke, whereas furnace coal was brought to a high temperature more rapidly and with a consequent smaller production of tar.

Although more attention is being paid to the installation of improved domestic grates, is the Brains Trust of the opinion that sufficient attention is being paid to the provision of adequate storage facilities for smokeless fuels?

Mrs. Brown was of the opinion that insufficient space was provided for fuel storage. As it was hoped that more appliances would be available for burning smokeless fuels and due to the fact that these were more bulky, more storage space should be made available, and she suggested that separate compartments should be fitted, preferably under cover, for smokeless and bituminous coal.

Mr. Redstone said that the accommodation provided should be at least three times the amount normally installed, and, if possible, a hopper provided instead of the present arrangement.

Mr. Roberts defined the various grades of domestic fuel, showing that smokeless fuels required more storage space than smoky coal.

Mr. Duguid added that his main trouble was to fill the limited space at his disposal.

Mr. Steel drew attention to the vice of continually using the poker, but agreed that more attention should be given to the provision of adequate storage facilities.

Can the Brains Trust state whether heat rays given off from smokeless fuels burning in domestic grates are more beneficial than those from coal fires?

Dr. Perry did not think that any distinction could be made between the two. Both gave off radiant heat, but he did not think that they gave off ultra violet rays which were more important for the well-being of the human body.

If the state of the atmosphere in large cities is so deplorable, can the Brains Trust account for the wonderful display of flowers and shrubs in public parks and gardens?

Beautiful displays were maintained at terrific expense for replacements, said Mr. Redstone. In some areas the cost of replacement was small, but in industrial areas the cost was very great, and if the atmosphere was cleaner the flowers would be more beautiful still.

Colonel Cousin in his report yesterday said that poor quality fuel was a frequent excuse for smoke emission. Can the Brains Trust state what kind of plant or accessories are required to make it possible to burn poor coal without smoke?

Mr. Steel said that when coal was distilled there must be sufficient air and draught for the products of distillation to be properly burned. Suitable plant was available for use in factories and power stations, but it was very difficult to design such apparatus for use in limited space. Before the war poor quality coal could be successfully burnt, but to-day we had trouble because of poor quality and variation in quality.

Mr. Roberts said it was largely a question of the distribution of ash.

Poor quality coal, said Mr. Duguid, was too often made an excuse for carelessness and lack of maintenance. If you wanted to produce black smoke, bituminous coal could be made to make more smoke than a low grade fuel.

Mrs. Brown added that it was difficult to burn low grade coal on the domestic fire without smoke, but it was possible to reduce the smoke with modern appliances.

Mr. Duguid entered into the dis-

cussion again by saying that the dark coloured smoke frequently seen coming from a factory chimney was not smoke but grit due to the forced draught furnaces which were put in and used to the fullest extent. When the draught was not regulated, grit and dust from the coal was blown up the chimney and the smoke coloured by grit.

Mr. Redstone said that special apparatus would have to be used if plants were continually being supplied with low grade fuels, and he would like to have Mr. Duguid's opinion on specific plant.

Mr. Duguid replied that it was quite obvious that the furnace would have to be designed to suit the fuel, and added that it was an important feature to have adequate space between the bars in small furnaces. It was an overriding feature that there must be adequate draught. There were furnaces suitable for different types of fuel, but no equipment was available that was suitable for all. He quoted an instance of 173 varieties of coal being delivered to works, but the problem could be tackled and experiments were now being undertaken by firms making coking stokers.

Can children living in a smoky city, providing they have good nourishing food with sufficient vitamins, be as healthy as they would be if they lived in the country?

Dr. Perry said children could not be so healthy in smoky cities. They were more likely to suffer from skin diseases than children living in country areas. The excellent feeling experienced when waking up in the morning and seeing blue skies had its psychological effect which could not be obtained in a smoky area.

Mr. Roberts emphasized that air was more important than food, as we consumed far more air per day than we did food. It was possible to cut off the supply of food for 24 hours and feel better for it, but it was certainly not possible to live for 24 hours without air.

Mr. Redstone reminded the audience that in some industrial areas over 50 per cent. of the sunshine was kept from the inhabitants. He told the story of the man who died when he arrived home from his annual holiday. A neighbour viewing the body said how brown he was, to which the widow answered that the holiday did him a lot of good.

In the interest of coal conservation, would it not be better to restrict the use of electricity to lighting power and traction—especially for the electrification of the railways—and to prohibit it for space heating, which could be left to gas, solid smokeless fuel and district heating?

Mr. Steel said no. He said the best way to deal with poor fuel was to use it in power stations and generate electricity.

Mr. Roberts said it required twice as much coal to generate electricity for a given amount of heat then if coal was carbonised to produce gas and coke.

Mrs. Brown remarked that it would be some time before the generating stations would be ready to supply all needs, and, therefore, for the time being solid fuel was extremely useful in the home. Gas or electricity would be expensive to the housewife to supply background heating throughout the entire day. It would be more economical to use solid fuel.

Mr. Steel added that the main thing was to have a supply of heat as and when you required it, and electricity could do this.

Mr. Roberts reminded them that the gas industry and the electricity industry were both engaged on a common front against smoke, and it would be best if each concentrated in performing work they could do most efficiently. He did not think that space heating could be done more efficiently by electricity than by gas.

Mr. Redstone concluded by saying that what was really needed was a national fuel plan.

Is it not time that there was a better method of sweeping chimneys, which at present often causes much work for the housewife? Can the Brains Trust make any suggestions for improvement?

Mr. Roberts said he could not suggest new methods, but did suggest the use of smokeless fuels and thus eliminate soot and the need for a sweep. He had

used smokeless fuels for eight years and had had no chimney swept.

Mr. Steel added " Why not get rid of chimneys altogether ? "

More people in towns use spectacles than in the country ; is this anything to do with the smoky atmosphere ?

Dr. Perry did not think this was the case, and it was probably due to the fact that people living in towns were engaged in closer work and for longer periods than people working in the open air.

Mr. Steel asked if it had any relation to the song " Smoke gets in your eyes."

Does the Brains Trust agree that the Victorian phrase " Smoke Abatement " is too timid and flabby for to-day, and, in the Society's name especially, should it not be replaced by "Smoke Abolition " or " Smoke Prevention."

Mr. Roberts said he was in favour of retaining the word " Abatement " because he did not believe in extremes.

Mrs. Brown was in favour of retaining the word abatement because we could not hope to entirely prevent or abolish, but we could abate, smoke.

It all depended on what you mean by smoke, said Mr. Duguid, as to him smoke was everything that came out of a chimney. It included ash and grit, and therefore the only way to abolish smoke was to abolish fires altogether, and therefore the question was not capable of being answered.

Mr. Redstone thought that smoke prevention was better than abatement, as prevention was positive and abatement was negative.

Mr. Steel was in favour of modifying the word smoke and adding atmospheric pollution.

Dr. Perry said that he was in favour of the words smoke abolition, as we no longer permitted sewage contamination of water, so why permit smoke pollution of the air ?

Can the Brains Trust say if there has been any real improvement in the state of the atmosphere during the last 25 years ?

Mr. Roberts said " Yes, unquestionably," and Mr. Duguid agreed.

Dr. Perry also agreed, and it was supported by the fact that the incidence of respiratory diseases was lower due to the improved condition of the atmosphere.

Mrs. Brown also said there had been an improvement, but if one compared Manchester and Swiss cities, it was obvious that we still had a long way to go.

Mr. Redstone was of the opinion that there was an improvement in some areas. But he thought that without proper measurement of smoke deposit in certain areas, he was uncertain as to whether there really had been any improvement.

Mr. Steel reminded them that more homes had been built, thus creating more smoke, and more industries were emitting invisible gases. It was more than ever necessary to take measurements wherever possible to see where there are improvements and where deterioration was taking place. Local Authorities should be encouraged to take more readings regarding the state of the atmosphere.

During the last war industrialists were encouraged to make more smoke, said Mr. Duguid, and he felt that a good deal of apathy had been left as a result of this order.

I live near a large hospital, the chimneys of which frequently pour out dense black smoke. I am told that the boiler plant is an old one and that no improvement can be expected until it can be replaced. Does the Brains Trust think this is a valid excuse ?

Mr. Duguid did not think this was a valid reason. He said that if there was no overloading there was no reason why the plant should not be operated efficiently. He insisted that men looking after boiler plant should be properly trained and recognized. In order to raise their status it was necessary to have apprenticeship and periods of training. He emphasized that plant could not be run efficiently if the people were not trained properly.

Mr. Redstone recalled the number of times they were told that nothing could be done about it just now.

Mr. Duguid said that the idea that improvements would cost a lot of money was entirely wrong. In many cases it only entailed minor adjustments.

In view of the appeals going out to save

fuel, especially by home consumers, to keep industry going, how can we get the latest equipment in new houses and at the same time save fuel and avoid "shedding the load" during the peak hours?

Mr. Steel said that perhaps the two parts of the question need not be related. As far as the electrical industry was concerned, he said it was necessary to shed the load by not using electricity during the hours when the load was so great that it could not meet all demands.

Mrs. Brown mentioned the fact that modern appliances gave heat in the mornings, which made it unnecessary to switch on electric fires.

Mr. Roberts assumed that the use of modern heating equipment was more efficient than the old, and therefore if modern equipment were installed we should save fuel and thereby reduce load shedding.

The Question Master, Mr. Stewart Swift, at the conclusion of the proceedings thanked, on behalf of the audience, all the members of the Brains Trust. He was quite sure that, to judge from the lively interest that had been evident throughout the whole of the session, the audience would agree with him in saying that the meeting, which was an entirely new innovation, had been a remarkable success. The questions had been good ones, and the answers both interesting and enlightening.

Resolutions

THE following resolutions were adopted by the Conference during the course of its discussions:

1. Solid Fuel Burning Installations in New Houses

That the Minister of Health and the Secretary of State for Scotland be requested to make a condition of qualification for their approval for new housing schemes, or for the issue of a licence in respect of houses built by private enterprise, that any solid fuel burning appliances proposed to be installed shall be on the Government list of approved or provisionally approved appliances.

2. Prohibition of Manufacture of Obsolete Appliances

The the Government be requested to implement as soon as practicable recommendation 2 (*c*) of the Domestic Fuel Policy report regarding the prohibition of the manufacture and sale of new appliances falling below approved standards.

3. Resolution to Local Authorities

That this Conference of the National Smoke Abatement Society:

(*a*) extends its thanks and appreciation to all the many local authorities and their officials who have co-operated in the survey of atmospheric pollution conducted by the Society;

(*b*) expresses its hope that other local authorities will even now assist by completing the forms sent to them in February;

(*c*) urges local authorities to co-operate more fully with the Department of Scientific and Industrial Research in making systematic observations of deposited and suspended matter and of the sulphur content of the atmosphere in their areas, especially where projected development may lead to worsening of conditions;

(*d*) urges local authorities to impress on proprietors of fuel burning plant the desirability of encouraging firemen to attend courses and examinations in boiler house practice, both of which should include practical work, and their acknowledgment in pay and status of the qualification thus conferred on those passing the examination.

* The action requested was taken by the Ministry of Health, with respect to local authority houses, in their Circular to Housing Authorities, No. 170/48, dated November 11th, 1948.

4. Colliery Chimney Smoke

That this conference is deeply concerned at the quantity of black smoke emitted from colliery chimneys, and requests the National Coal Board to take all necessary steps to effect a remedy.

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RECENT N.S.A.S. PUBLICATIONS

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Proceedings of the Cheltenham Conference, 1948. A full record of the papers and discussion, including an Address by the Rt. Hon. Hugh Gaitskell, M.P., Minister of Fuel and Power. 3/6d. (3/8.)

Proceedings of the Edinburgh (1947) and Brighton (1946) Conferences are also still available. 4/6d. (4/8d.) and 2/- (2/2d.) respectively.

The Law of Smoke Nuisances, by W. R. Hornby Steer, M.A., LL.B., Standing Counsel to the Society. Revised edition, 1948. Fully covers the law as it applies to England and Wales and with a new chapter on the post-war legislation now being secured by some local authorities ("prior approval" and "smokeless zones," etc.). With tables of statutes and cases and the relevant sections of the Public Health and other Acts. Cloth, 5/- (5/3d.); paper-backed, 3/- (3/2d.)

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NATIONAL SMOKE ABATEMENT SOCIETY

National Survey of the Sources and Incidence of Atmospheric Pollution

INTERIM REPORT

By

A. J. Cousin, M.Inst.F.

Presented at the Conference of the Society held at Cheltenham, September 29th to October 1st, 1948, and reprinted from the *Proceedings* of the Conference.

Price 1/-

INTERIM REPORT

On

National Survey of the Sources and Incidence of Atmospheric Pollution

By A. J. COUSIN, M.Inst.F.

1. General

At the Annual Conference of the National Smoke Abatement Society in October, 1947, at which 450 representatives of local authorities were present, the following resolution was passed:

> "That the Executive Council be requested to take the necessary steps to undertake a nation-wide survey of the sources and incidence of atmospheric pollution, and that local authorities be urged to co-operate with this object in view."

1.1. The Executive Council decided to proceed by addressing to every local authority a questionnaire in two parts, general and detailed, on two forms, green and yellow respectively, with which many will be familiar.

1.2. It was with some diffidence that the Executive Council adopted this course in that it laid an additional burden upon overworked staffs preoccupied with their statutory duties. Moreover, the Society, being a voluntary body, had no authority to call for a return of this character, and the value of the Survey would depend entirely on the extent to which Local Authorities and their officers would be prepared to co-operate. A further difficulty would be likely to arise from the impossibility of establishing any common standard of assessment of atmospheric pollution, unless its measurement were undertaken by scientific methods.

2. The questionnaire was addressed to the following bodies in England and Wales and in Scotland, and replies were received from the number indicated in the second column.

	Sent to	Replies Received
England and Wales		
London County Council, City of London and Metropolitan Boroughs	30	22
County Boroughs	83	66
Municipal Boroughs	309	169
Urban Districts	572	261
Rural Districts	475	170
	1,469	688
Scotland		
County Councils	34	12
Royal, Parliamentary and Police Boroughs	195	61
	229	72

2.1. Of the 198 local authorities represented at the Edinburgh Conference, who supported the resolution, 149 have sent in returns.

3. Immunity from Atmospheric Pollution

Of the authorities that have made returns, some 140 in England and Wales and 15 in Scotland have reported they suffer from no atmospheric pollution.

3.1. Such a conclusion arrived at by such a large number of local authorities gives cause for thought, particularly in the light of evidence that has been adduced hitherto.

3.2. At the Conference in Edinburgh last year it will be remembered, Lord

Sempill referred to an incident when his plane was parked in the open in Cornwall throughout the night, during which a slight rain fell. In the morning the plane was covered with a coating of soot, carried by the wind from the Midlands.

3.3. Mr. Entwistle of the staff of the Meteorological Office of the Air Ministry reported the difficulties attributed to smoke experienced by pilots flying over Great Britain or from Britain to the continent. Banks of smoke are frequently found at great distances from the area in which they were produced.

3.4 The late Sir Frank Baines reported on many occasions on the damage by the corrosive action of atmospheric acid to stonework of historic Abbeys in Yorkshire and in the Wye Valley far removed from any source of smoke.

3.5. In the survey under discussion, one island off the West Coast of Scotland reported that, with the wind in a certain direction, it suffered from heavy deposits of soot from a distant industrial area.

3.6. In view of the extensive evidence of the widespread dispersion of smoke and acid in the atmosphere over Great Britain, and the universality of domestic smoke, these professions of complete immunity may give rise to some pardonable scepticism.

4. Standard of Assessment

The absence of a common standard of assessment of atmospheric pollution offers a major difficulty. Where a local authority is sufficiently interested to tackle the problem scientifically and install solid and sulphur dioxide gauges, the way is clear; but where the authority relies on the unaided impressions of its officers, very wide differences in outlook are apparent.

4.1. It is well-established that domestic chimneys are responsible for at least half of the general atmospheric pollution in Great Britain. However, unless an individual is made smoke conscious by seeing smoke issuing from chimneys resembling those with which the Central Office of Information covered our hoardings, he seems to be unconscious of the equal or greater amount of smoke issuing from the thousands of house chimneys in his area. This attitude of mind is illustrated by the tone of several of the replies in respect of areas alleged to be immune, which are quoted below:

	Population
Rural Districts	
"We have no large industrial plants to pollute air"	12,000
"No smoke-producing industries"	7,400
"No industrial premises of any size"	17,000
Urban Districts	
"Small coastal resort with no industries"	12,000
"There are no industrial premises in the area"	3,000
Boroughs	
"Non-industrial area"	24,000
"Very few industrial plants within the borough"	64,000
"Negligible owing to there being no factories"	26,000

This last town lies in a deep depression in which, in calm weather, a heavy pall of domestic smoke can be seen.

4.2. One country borough reported that it suffered from no atmospheric pollution and no useful purpose would be served by filling up the forms. Ironically enough, a photograph of this particular town was published some time ago to show a heavy pall of smoke hanging over the town. On a second approach however, the authority sent in a very comprehensive return.

4.3. Equally surprisingly, a metropolitan borough reported: "This is largely a residential area, and as such has no real problem of atmospheric pollution . . . has experienced no trouble from such pollution drifting from other areas."

The mean deposition in the area is somewhat higher than that at any of the deposit gauge stations in Newcastle-on-Tyne.

4.4. An Urban District some twenty miles from London reported: ". . . is predominantly residential and fortu-

nately it has no atmospheric pollution in any way."

The above quotation from reports from areas alleging complete freedom from atmospheric pollution are illuminating. Reports from areas heavily industrialized rarely fail to mention the presence of domestic smoke, whereas even densely populated areas frequently fail to mention smoke from domestic chimneys, but confine their remarks to public buildings, laundries and so forth.

4.5. There are, however, noteworthy exceptions as several mainly residential areas have reported that they suffer from domestic smoke only.

5. Nature of Replies by Local Authorities

Another outstanding difference is the manner in which forms have been filled up. Those from some local authorities have been completed with meticulous care, others have been dismissed very summarily, and in a few cases officers omitted to fill in the name of their local authorities.

5.1. One local authority submitted a summary of deposits in different parts of the town during working days and holidays in summer and winter, from which it was possible to deduce that over 50 per cent. of the smoke was due to that emitted from house chimneys. Comparative sulphur dioxide records indicate that over a half was produced by domestic grates, and that this was much heavier in parts of the town where old houses were still fitted with old-fashioned grates. Ultra-violet ray meters showed that the town got approximately one-third of the light that reached the immediate rural areas.

5.2. Another local authority provided a large scale map showing lines of equal solid deposition. This showed the heaviest deposition in the neighbourhood of heavy industry and in the old part of the town where houses were still heated by old-fashioned grates.

5.3. Another authority made the survey the occasion of a visit to all the steam-raising plants in their area and in this they have had the willing co-operation of the firms concerned. They have given a very comprehensive return showing the cause of heavy smoke production. In one instance opencast slack was being fed to an underfeed stoker, which promptly became choked. A low-pressure Lancashire boiler was being fired with rubber waste which could not otherwise be disposed of, while a locomotive type boiler fired with wood waste was the cause of heavy pollution.

5.4. It is gratifying to note that a number of local authorities are establishing air pollution stations with deposit gauges and sulphur recorders, in their areas.

One Authority has drawn up a special clause for inclusion in leases in connection with land under their control and used for industrial development, and laid down that all houses under their control shall be fitted with grates for smokeless fuel.

5.5. For these comprehensive reports and for many others prepared with great care and contributing much useful information, and for many supplementary reports that have been submitted, the Society offers its sincerest thanks to the local authorities responsible, and hopes that local authorities, whether they have contributed or not, and whether or not they are members of the Society, will be able to utilize the results of the survey in overcoming the atmospheric pollution in their own areas.

5.6. Having outlined the difficulties and drawbacks involved in the completion of the survey, the reservations that will have to be applied in interpreting the result will be apparent.

6. Smoke attributable to low-grade fuel

Where smoke is reported, its production is frequently attributed to inferior fuel. This applies to some 50 per cent. of the returns, and it occurs with such regularity that it requires careful consideration.

6.1. Some inspectors simply record the fact that the smoke produced is

stated to be due to inferior fuel, and were it generally true, the only conclusion that could be arrived at would be that all coal deliveries had been degraded.

6.2. When one remembers how easy it is, even with the best of fuel such as a dry Welsh steam coal, to produce large volumes of smoke by taking the appropriate measures, one is inclined to enquire whether the production of smoke in many instances is not due to causes other than poor quality of fuel. Some authorities record that plant has been converted to oil-firing but in some instances it is noted significantly that the conversion has not been accompanied by any reduction in the smoke emitted.

6.3. A number of inspectors are of the opinion that inferior fuel is not the sole cause of smoke and add that the boiler plant in question is obsolete and overloaded. In other instances, necessary renewal parts are stated to be unprocurable, while in others the inspectors have added that the substitution of hand for mechanical firing can be blamed. Frequently the inspector has come to the conclusion that the cause of smoke is bad firing, and in one instance it is stated that a visit of the Regional Engineer of the Ministry of Fuel and Power was instrumental in abolishing the smoke entirely.

6.4. In some instances the production of smoke is attributed to the inability to obtain the kind of fuel for which a mechanically fired plant was designed. One authority attributed most of the industrial smoke to pitch-fired boilers.

6.5. In another instance the inspector is of the opinion that variation in quality of fuel fed to mechanically fired plant was responsible for smoke production.

6.6. A steam-raising plant can be built and adjusted to consume smokelessly any kind of coal. In this connection, members of the Executive Council will recall the visit on April 27th to the laundry of the London Co-operative Society at Romford, Essex, where they saw a poor grade of heavily oxidized opencast coal of about 9,000 B.Th.U. per lb., being burned smokelessly in an economic boiler fitted with a coking stoker. If, however, a fairly constant quality of fuel—good or bad—cannot be relied on, it is difficult to see how waste of fuel and the formation of smoke is to be avoided, even with the best of mechanically fired plant.

6.7. One Sanitary Inspector very pertinently remarks that loss of standards due to war-time encouragement in the emission of smoke and now in many cases poorer fuel, is becoming a permanent excuse from both the management's and from the stoker's point of view.

The Chief Sanitary Inspector of one industrial area records that from his experience it is essential to employ a higher standard of fireman, encouraged by a higher scale of pay to study the technique of his work.

The Chief Sanitary Inspector of another authority has publicly announced that in his area records of fuel supplied to many plants in his area have been kept since before the war, and it is found in the majority of instances that grades in use to-day compare very favourably with those supplied in 1938.

A large Metropolitan Borough records a considered opinion that there is a tendency amongst combustion operators to lay all the blame on the fuel, whereas insufficient attention is being paid to the principles of complete and efficient combustion.

One authority records that although fuel is inferior, better supervision of firing has improved local conditions and that one firm attributes a saving of several hundreds of tons of coal to this cause.

One is led to the conclusion that the plea of inferior fuel is rather overdone and is likely to be used as an excuse for inefficiency for some time to come.

6.8. The value of stokers' training courses is frequently acknowledged. One authority says that the lack of training facilities for stokers had had adverse effect since the early days of the war while a neighbouring authority

says that a well-attended course for firemen is held at their technical college.

6.9. Some authorities complain of the difficulty of obtaining domestic appliances for burning smokeless fuel, while others refer to the difficulty in obtaining the smokeless fuel itself, and also of its high price. One Sanitary Inspector makes the rather surprising statement that domestic smoke is due mainly to prefabricated bungalows, which one understood were fitted with the most up-to-date smokeless fuel-burning appliances !

7. Service of the Ministry of Fuel and Power

The assistance that has been given by the engineers and stoker instructors of the Ministry ot Fuel and Power is frequently fully acknowledged but the general tenor of reports made by many local authorities, leads to the conclusion that they might make fuller use of the technical services provided by the Ministry. The services of these officers is available free of charge to give advice at any time and the Ministry is ready on all occassions to offer its co-operation in advising on the control of plant, and in the training of firemen.

7.1. The Ministry, in conjunction with the City and Guilds of London, has arranged a series of courses at Technical Colleges throughout the country in the following subjects :

(*a*) Boiler House Practice, Preliminary, Intermediate and Advanced grades.

(*b*) Steam Utilization.

(*c*) Fuel Technology.

(*d*) Operation and Maintenance of Fuel Using Plant (Primarily for Works Engineers).

(*e*) Operation and Maintenance of Mechanical Stokers.

The support of local authorities for these courses is invited. A list of some of these courses for the 1948-49 session is given in the August number of " Fuel Efficiency News," published by the Ministry, and full particulars can be obtained from the Secretary of the Local Fuel Efficiency Committee at the nearest Regional Office of the Ministry of Fuel and Power. Where there are sufficient applicants for a particular course of instruction, the Ministry is prepared to arrange for the requirements to be met.

7.2. Training schemes, however, will be of little avail without the support of employers who should be encouraged to appreciate that a properly trained fireman, capable of meeting the requirements of the works with a minimum fuel-consumption, and with no fuel sent up the chimney in the form of smoke and unconsumed gases, is a more valuable asset than a man capable only of shovelling coal on to a fire.

7.3. A fireman on passing his test might be given a certificate of a colour appropriate to the grade, signed by the Ministry and the City and Guilds of London, to fit into a small frame to hang in the boiler house. The certificate should entitle the fireman to a graded bonus that might be co-related to a bonus scheme such as that outlined in the Spring number of " Smokeless Air " for 1948.

8. Sources of Pollution

The sources of pollution recorded are many and varied.

8.1. *Collieries*. In colliery districts complaints arise in respect of steam-raising plant, burning spoil banks, and domestic smoke from the consumption of miners' coal. The first mentioned is probably occasioned by the use of low-grade unsaleable fuel, but it might be possible to modify the boilers so that the consumption of low-grade fuel would not necessarily be accompanied by volumes of smoke. Burning spoil banks are an old problem on which much remains yet to be done.

The smoke caused by the burning of the liberal issue of miners' coal is the source of a large number of complaints by local authorities, some of whom point out that the coal is wasted in old-fashioned grates kept burning day and night. It is probable that much greater service to the housewife in the way of space-heating, cooking, and hot water could be obtained by the consumption of a half or less of the

present issue of coal, were it consumed in an efficient type of stove or grate, and the formation of smoke would be thereby largely avoided.

8.2. *Railways*. Railways are frequently recorded as the source of atmospheric pollution—either from the engine sheds or round houses when firing-up or from shunting in marshalling yards. No ready remedy seems to be at hand in respect to the former, while trains continue to be drawn by steam locomotives, but some amelioration might be obtained in respect of the latter from the increasing use of Diesel shunting locomotives.

8.3. *Shipping*. Local authorities of Port areas complain frequently of the smoke from shipping, sometimes occasioned by deep-sea ships and at other times by river and harbour tugs. It looks as though much greater use might be made of the furnace door for providing a controlled supply of secondary air, devised during the war by the Fuel Research Station. One authority has recorded that during 1947 visits were made on account of smoke to seven vessels, all oil burners. A slight adjustment of oil feed and burner valves was all that was required to avoid the nuisance.

8.4. *Power Stations*. Complaints are recorded frequently—in some 80 instances—of sulphur and grit from power stations. With the establishment of a growing number of large modern power stations, the problem of emission of oxides of sulphur and grit will be of increasing magnitude and difficulty, the solution of which, whatever form it takes, is likely to add to the cost of electricity. Since, however, electricity has become almost the universal source of power and the source of much smokeless heat in the modern world, increased cost may have to be faced.

8.5. *Metallurgical Processes*. Blast furnaces, cupolas, and other metallurgical processes appear frequently as responsible for much atmospheric pollution.

8.6. *Coke Ovens and Gas Works*. Coke ovens and gas works are frequently the cause of complaint, generally in respect of dispersion of grit. In the case of gas works, it arises usually from horizontal retort houses and the blast from water gas plant in respect of which there seems to be no remedy. There are, however, several complaints of steam-raising plant at gas works.

One local authority reports that the chief discomfort arises from the grit from a battery of coke ovens. The authority has been pressed to erect a number of aluminium bungalows in close proximity to the coke ovens and it is impossible for windows ever to be opened on account of heavy deposit of grit. An extension of the battery is in progress when the nuisance will probably be worse.

8.7 *Laundries*. In more than 150 instances, the laundry is the cause of much atmospheric pollution. In fact a large section of the industry seems to be engaged at a considerable cost to themselves in dispersing soot that they are prepared, at a price, to remove from our fabrics.

One county borough reports that it has five laundries all of which are responsible for heavy smoke, while another seaside town records three laundries all emitting heavy smoke.

One local authority, in reply to the question on the form relating to Part I of the Survey as to whether conditions were better or worse than in 1939, replied that they were much better, and gave as a reason the fact that the local laundry had been burnt down. Many authorities reported their only source of smoke as domestic chimneys and the laundry. Sanitary Inspectors frequently report that the steam-raising plant is old and overloaded, and that replacement parts are not obtainable. While not suggesting that the drastic remedy above referred to should be applied universally, it may be that something might be done to enable laundries to raise steam without defiling the atmosphere. The one at Romford already referred to is an outstanding example.

8.8. *Clay Industries*. Brickworks, tileries and potteries appear with regularity as defilers of the atmosphere. Some of the more highly developed potteries and tileries, it is well known,

are in course of turning over to smokeless tunnel ovens, but it is a question whether something could not be done to improve the performance of the local brick and sanitary pottery works.

8.9. In addition to the sources of pollution mentioned above, there frequently occur as offenders breweries, textile and paper mills in respect of their steam-raising plant, chemical works from fumes and also steam-raising, and dyeworks where large volumes of low-pressure steam are required at intervals. There are many complaints of obsolete, worn out and overloaded plant and it is recorded in several instances that new plant or replacements are on order but cannot be obtained. In one case it is recorded that a plant designed to burn coke has had to burn raw coal owing to coke being unobtainable. Dust from cement works is a frequent source of complaint. In one district a committee of representatives of local authorities has the matter under consideration. One authority records the collection of dust from a quarry in ducts but of the final disposal of the dust by blowing it into the air, when it is distributed over dwelling houses. Government establishments such as Royal Ordnance Factories are frequently mentioned as responsible for atmospheric pollution. A town in Scotland reports that the purifiers at its gas works are inadequate to deal with the increased output.

9. There are also frequent complaints about public institutions such as baths, hospitals, etc., which would seem to be within the control of local authorities themselves. Again another municipal plant that seems responsible for much smoke is the refuse destructor. It is said in some instances to be due to attempts to burn wet refuse, which of course is likely to give trouble.

9.1. On top of this is the all-pervading domestic smoke and the steam-raising plant associated with small local industries. Very often the latter are fired with wood or other refuse, which makes a readily available source of heat and which is capable of being burned smokelessly in proper plant, but when fed irregularly on to the fire in small locomotive type or vertical boiler, is likely to be the source of great annoyance to the neighbourhood.

9.2. One or two authorities exhibit some anxiety as to the effect of the establishment of the projected satellite towns in their areas.

10. **Outlook of Local Authorities**

The Survey has disclosed the great difference in outlook that exists on the problem of the pollution of the atmosphere. In some quarters mankind seems to have become so accustomed to living in a smoke-laden atmosphere as to be unconscious of his environment.

10.1. In their response to the Society's questionnaire, local authorities display very different outlooks. There are those intensely conscious of the problem, anxious to take systematic measures to ascertain the intensity of pollution and ready to take all measures within their powers to improve the conditions of their area. They frequently give evidence of a sense of frustration in the lack of interest of owners of fuel-burning plant, and of the employees operating it, and in the lack of support from higher authority. They have generally gone out of their way to give the Society all available information, and for the helpful attitude they have adopted the Society expresses its gratitude.

10.2 Other authorities have shown a limited interest, sufficient to cause them to become associated with the movement to obtain a cleaner atmosphere and to obtain such information on the subject as may become available. The Society is grateful for their support and their help, and ventures to express the hope that their interest will increase and that they will yet take a more active part in the campaign. Quite a large proportion of those addressed disclose a complete lack of interest : some have indicated their lack of interest, while others have ignored altogether the Society's questionnaire. It is hoped that their interest in this important problem will be awakened and that they will ultimately take their places in the

campaign for the prevention of smoke, which not only defiles our land, but is the visible indication of the wasteful use of our vanishing supplies of fuel.

10.3 Many local authorities record drift of pollution from other areas, and in highly developed areas such as Lancashire, Yorkshire and London, this is inevitable. This factor gives some force to the suggestion that has been put forward that joint local committees should be established in all areas.

10.4. It is worthy of note that although atmospheric pollution is the responsibility of the Local Authority's Medical Officer of Health and the Sanitary Inspector, the returns in many instances bore only the name of the Town Clerk or Clerk to the Council. This applies to about one-third of the returns reporting no atmospheric pollution.

11. Conclusion

The preceding summary, subject to such reservations as may have to be made on account of the incompleteness of the return and for the reasons already mentioned, gives a brief outline of the commonest causes of atmospheric pollution. It accounts for some fraction of the millions of tons of smoke, soot and associated unconsumed gases that we continue to put into the atmosphere each year, and as a result are compelled to spend considerable sums in cleaning and repairing stonework, replacing corroded metal work, renewing paint, washing fabrics and so on.

11.1. Has the Survey been worth while ? This question can be answered very definitely in the affirmative. It has shown first of all that the principal sources of pollution fall into separate categories :

There are those associated with industries such as coal-carbonization, metallurgical processes, power stations, etc., where the smoke, sulphur and grit problem is not capable of a ready complete solution and where research and experiment on a considerable scale is still necessary.

In these and in other instances, partial solutions would seem to be available. There seems to be no reason why steam-raising plant at colleries should not be operated in a manner to give less offence although a good deal of work appears to be necessary on spoil banks. The gradual substitution of Diesel shunting locomotives should improve the conditions in marshalling yards, but while the steam locomotive is the chief source of railway traction, engine sheds are likely to be the source of atmospheric pollution. The increasing use of water-tube boilers in new ships and improved control of combustion should contribute to some improvement in conditions of which local authorities in port areas complain, while in other instances a remedy is to hand, in the furnace door produced during the war by the Fuel Research Station, the use of which should be encouraged.

On the other hand, many other sources of pollution should be capable of being remedied by means already to hand. The steam-raising plant of textile mills, breweries, laundries, and other industries should be capable of more efficient operation to the financial advantage of their owners, by some improvement in the technique of firing, and by some modification of plant as and when circumstances permit. There is a general consensus of opinion among officers of local authorities that stoking leaves much to be desired. A remedy might be found in the adoption of a scheme recommended by some of them, in which firemen, or at least the younger of them, should be examined and on certification promoted to a higher scale of pay. Some of the courses already available for training firemen have been referred to briefly in paragraph 7 of this report.

12. With regard to domestic smoke that forms such a high percentage of the general atmospheric pollution, it is anticipated that by the time this report is presented the production of stoves and open grates for burning smokeless fuel will meet the requirements for all new houses. There would then be no reason why housing authorities should not install such appliances in all new housing schemes. Could we hope that the Ministry of Health and the Depart-

ment of Health for Scotland would consider the advisibility of instructing local authorities to insist on the installation of stoves or grates for smokeless fuel in all new houses whether publicly or privately built. Even where smokeless fuel is not immediately available, these grates will burn bituminous coal more efficiently, and consequently produce less smoke that the older types of grates, until such time as smokeless fuels are available in sufficient quantities, and it is to be hoped, at lower prices than at present.

12.1. As the production of smokeless appliances increases, it should be possible to evolve a policy to encourage the replacement of grates of older types by those for burning smokeless fuel, or in blocks of flats and tenements by efficient central heating systems.

13. The Society's efforts to carry out this national survey of atmospheric pollution, the results of which have been outlined above, have made it clear that an authoritative survey will be possible only if undertaken under Government authority by the Departments directly concerned, with systematic observations and measurements. Such a survey is a matter of some magnitude, and before that can be launched there is much that has been disclosed by the Survey that can be undertaken to prevent a very considerable part of the pollution of the atmosphere of the country.

14. This very brief interim report is based mainly on the report in general terms given on Part I of the survey, reinforced by reference to the detail on Part II. The analysis of Part II will be a matter of some magnitude on whatever basis it is undertaken. This will be carried out in due course: but meanwhile many members of the Conference may have views as to how the analysis should proceed.

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National Smoke Abatement Society

HARROGATE CONFERENCE

28th September/1st October 1949

Members and Delegates, Etc. Attending

(List corrected to 19th September 1949)

Acton, G. H. (C.S.I.)	Tipton
Ainsworth, G. (C.S.I.)	Swadlincote
Allison-Beer, County Cllr. G. ...	Kent C.C.
Allemby, G. H.	Dearne
Anderson, I. B. (S.I.)	Port Glasgow
Anderson, J.	International Combustion Ltd.
Anderson, Cllr. J.	Chesterfield
Appleton, W. F. (C.S.I.)	Portsmouth
Archer, A. (C.S.I.)	Halesowen
Armstrong, Ald. E. A.	Derby
Arnold, Ald. Miss A.	Coventry
Bacon, W. N.	City of London
Bainbridge, Cllr. W. H.	Hetton
Balfour Birse, Dr. E. A.	Department of Health for Scotland
Ball, J. (S.I.)	Cannock
Bamford, Cllr. G. H. J.	Shoreditch
Banwell, H. A. (S.S.I.)	Swindon
Barrett, Ald. W.	Bath
Baskett, R. A., B.E.M. (C.S.I.) ...	East Ham
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Bate, W. (C.S.I.)	Wallasey
Bates, A. (County Planning Officer) ...	W. Riding C.C.
Battersby, Dr. J. (M.O.H.)	Shipley
Beattie, Bailie G.	Port Glasgow
Beaumont, J. W.	Sanitary Inspectors' Association

Beaumont, W. (C.S.I.)	... Coventry
Beavon, Ald. G. E.	... Midlands Joint Advisory Council for the Abatement of Smoke & Atmospheric Pollution
Bence, Cllr. C. A.	... Cardiff
Berridge, Cllr. L. E.	... Edmonton
Birch, Ald. N., J.P.	... St. Helens
Bishop, Cllr. A. V.	... Ipswich
Black, W. L. (C.S.I.)	... Wallsend
Blackburn, Cllr. C.	... Hemsworth R.D.C.
Blakey, R. (S.I.)...	... Stanley, (Yorks)
Blenkinsop, A., M.P. (Parl. Sec.)	... Ministry of Health
Bowen, F.	... Coal Utilization Joint Council
Brearley, H. (C.S.I.)	... Mexborough
Breward, Cllr. Mrs. W. ...	... West Hartlepool
Britcher, F. G. (S.S.I.)	... Egham
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Burnip, Cllr, J.	... Easington R.D.C.
Burns, H.	... Los Angeles Smoke Control
Burrows, J. H. (S.S.I.)	... Eston
Burt, Miss J. W.	... N.S.A.S.
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Cleave Cross, D.	... Institution of Gas Engineers
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Marrison, F. C.	... National Coal Board
Marron, Ald. S. T., J.P. ...	... Oldham
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Moore, Cllr. R. E.	... Meriden R.D.C.
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Morris, Cllr. J.	... Mynyddislwyn

Morris, Cllr. R.	... Blaenavon
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Orr, J. H.	... Member
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Owen, Cllr. W. K., J.P. ...	... Neath
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NATIONAL

SMOKE ABATEMENT SOCIETY

Proceedings of the Harrogate Conference 1949

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This is one of the many publications of the National Smoke Abatement Society. For a complete list write to the Society for its current "Guide to Publications on Smoke Prevention and Allied Subjects," which contains, in addition to the Society's own titles, particulars of other books, reports and papers, any of which may be purchased from the Society. The list is classified according to subject—the Law, Conference Proceedings, General, Historical, Smoke Prevention Administration, Industrial Smoke, Domestic Heating, Technical and Scientific, and Industrial Pollution.

Contents

The Presidential Address was read by the retiring President, Lord Simon of Wythenshawe, at the Annual General Meeting on September 28th. The Conference proper was opened on September 29th by the Deputy Mayor of Harrogate, Councillor E. Robinson. The Sessional Chairmen were Dame Vera Laughton Mathews, the incoming President of the Society, Alderman J. S. Tennant, Chairman of the Health Committee, Harrogate, and John W. Beaumont, Deputy Chairman of the Executive Council of the Society.

PRESIDENTIAL ADDRESS

A Survey of Domestic Smoke Abatement

by

LORD SIMON OF WYTHENSHAWE

IT is an honour and a pleasure to be elected as President of the National Smoke Abatement Society in my seventieth year. I am to-day going to attempt to outline the history of smoke abatement over the last fifty years and hope you will forgive me if I begin by setting out my qualifications for this task.

I began a business career in Manchester in 1901, living in the south of the city, and almost every winter's day for a quarter of a century as I drove to my office I met the too familiar pall of smoke just about at the University.

So the first society I ever joined was the well-known Manchester and Salford Sanitary Association under the chairmanship of that great Manchester citizen, T. C. Horsfall; one of its chief activities was to work for the cleaning up of the atmosphere of Manchester. Later I took an active part in the Manchester Smoke Abatement League and then became secretary of a national Smoke Abatement League which had its headquarters in Manchester and was one of the predecessors of the present Society. For twelve years I was a member of the Manchester Public Health Committee which was fairly energetic in dealing with factory chimneys; some of the members insisted that it was possible to trace the boundary between Manchester and Salford by following the line of smoky chimneys, all of which were in Salford!

After World War I, I became Chairman of a sub-committee of the Manchester Public Health Committee known as the Atmospheric Pollution Board, which undertook what I believe to have been the first serious scientific investigation into the efficiency and the smoke-producing qualities of our old enemy—the open coal fire. It also undertook what I may perhaps call the classical investigation into the extra cost of the household wash in Manchester as compared with Harrogate, and provided evidence (verified by a firm of chartered accountants) that the extra cost, due to the smoke of the Manchester atmosphere, of this one item alone was no less than a quarter of a million pounds per annum. I should like to take this opportunity of paying a tribute to the work done in the smoke abatement field in those days by our old friend Mr. Will Melland, to whose initiative this particular inquiry was largely due.

Next came the Committee on Smoke

Abatement appointed by the Minister of Health under the chairmanship of Lord Newton. Its report in 1920 was the first official recognition of the importance of domestic smoke. I was a member of that committee and at that time wrote my first book with the ambitious title " The Smokeless City." Then for twenty years I gave up direct work on smoke abatement; though I was closely concerned with housing, and took an active, but I am sorry to say, quite ineffective interest in trying to secure the installation of smokeless appliances in the new houses.

In 1945 I became a member of the Egerton Committee on Heating and Ventilation appointed by the Department of Scientific and Industrial Research, and then Chairman of the Committee on Domestic Fuel Policy appointed by the Ministry of Fuel and Power. I apologize for these lengthy personal details; the sole object is to show that I happen to have perhaps as long and wide experience of smoke abatement problems as anybody in the country.

Looking back over the history of smoke abatement it divides itself naturally into three stages:

Stage I goes back to the first protests against the smoke nuisance and ends with World War I.

Stage II covers the inter-war period.

Stage III begins with the end of World War II.

Stage I

The early history of smoke abatement is marked by innumerable angry protests against the smoke nuisance and a good deal of punitive legislation. The earliest such action of which I know was in 1307, when circuit justices in London were commissioned " to enquire of all such who burn sea coal in the city, or parts adjoining, and to punish them for the first offence with great fines and ransomes, and, upon the second offence, to demolish their furnaces."

So far as we know this was quite ineffective and the same kind of thing went on equally ineffectively over the centuries. About the beginning of this century local authorities began to prosecute manufacturers for the emission of black smoke. Where it was done on a systematic basis it had some substantial success. But it is roughly true to say that action was still confined to prosecution and that neither the Government nor local authorities had begun to use scientific methods and to study the problems of efficient and smokeless combustion. And it is undoubtedly true that neither the Government nor local authorities had begun to give any attention to the domestic smoke problem. The old-fashioned open coal grate and smoke-producing kitchen range were still being generally introduced with no protest whatever.

The effective smoke abatement movement, so far as domestic smoke is concerned, dates from about the end of World War I. It was only then that the importance of domestic smoke began to be realized and that research and development began to be undertaken in that field both by private enterprise and the Government.

Stage II

The story of factory smoke during Stage II is one which covers large extensions in the use of electricity; the considerably increased use of gas; great improvements in the structure of boiler plants for efficiency and smokelessness; and steadily increasing cooperation between local authorities and manufacturers in making combustion more smokeless by the training of stokers, and in other ways. This has been and is a continuing process; great progress has been and is being made towards a really satisfactory state of affairs. The story of the domestic smoke problem is a very different and a much more difficult one and I propose, therefore, to confine my address today almost entirely to the domestic problem.

The landmark in the first years of Stage II was, of course, the publication of the Newton Committee's report in 1920; the first public and authoritative report which pointed out the immense importance of the damage done by domestic smoke. A good deal of new

evidence was available to the Newton Committee mainly based on the scientific work carried out in the years just before 1920. In particular, there had been many investigations into the damage done by smoke: the damage to the health and spirits and vitality of human beings through poisoning by acid and tar and through the cutting off of sunlight; the damage to trees and plants and crops; the damage to buildings. New evidence was also available as to the preponderating part played by domestic smoke in causing this damage.

Research into fuel efficiency and smoke emission had begun at the Fuel Research Station; the gas industry had developed efficient domestic appliances of different kinds; the electricity industry was beginning to follow suit. Other researches were going on; for instance, it was a startling innovation for the Manchester City Council to make an annual grant up to £500 to its Air Pollution Advisory Board for purposes of research. The work was carried out in the Manchester College of Technology with the help of leading scientists from the University and was, I think, the first serious research into the efficiency and smoke-producing qualities of the open coal fire. It is interesting that the work was under the direction of Dr. Sinnatt, who afterwards became the head of the Government Fuel Research Station.

The Newton Committee first met in March, 1920. So impressed was it with the urgency of using better methods of domestic heating in the large number of new working-class houses which it was hoped were to be rapidly built that it actually produced an interim report in three months, pointing out that the open coal fire and the old-fashioned kitchen range were "inefficient, wasteful of fuel and labour, and productive of smoke." Better appliances and methods were available though much research was still required. It recommended that:

1. The Government should decline to sanction any housing schemes unless specific provision was made in the plans for the adoption of smokeless methods for supplying the required heat.

2. The Government should encourage the co-ordination and extension of research into domestic heating problems.

The Committee was wise and right. It need not have been in such a hurry. Lord Newton wrote in 1922: "The very Ministry which was established to protect the health of the people has hitherto completely ignored the damage, waste and discomfort caused by domestic smoke." And twenty years later that same Ministry had still taken no action whatever under either of the recommendations of the Newton report.

The main report, published a year later, repeats the same recommendations and ends with the words: "The initiative rests, of course, with H.M. Government, and we trust that the necessary action, which has been long overdue, will be taken at the earliest possible moment."

The Newton report was an admirable document. It is a lamentable fact that so far as action by the Government was concerned it might just as well never have been written.

Stage III

The beginning of the third and final stage in the history of smoke abatement is marked by the creation of the Ministry of Fuel and Power in 1942. Owing to the grave shortage and high price of coal, more efficient consumption had become an urgent national necessity and the Ministry from the beginning meant business. Over one-third of our coal is used in one form or another for domestic purposes, so the Minister in 1945 appointed a strong committee, of which I was Chairman, with the following terms of reference: "To consider and advise on the use of fuels and the provision of heat services in domestic and similar premises, in the interests of the occupants and of the nation, with special regard to the efficient use of fuel resources and to the prevention of atmospheric pollution."

The report was published in 1946 and this is how we summed up the position as regards domestic heating.

"The four million houses built in the

inter-war period are probably larger than houses in other countries for the corresponding income groups, yet the area of the house properly warmed for comfort during the winter is probably smaller than in any other civilized country. . . .

" Our coal is used for domestic heating with a degree of inefficiency which is not, so far as we can ascertain, even approached in any other country in the world. . . .

" Over 80 per cent. of domestic heating is provided by burning bituminous coal mainly in open grates or in kitchen ranges. The open grate has always been the greatest sinner in smoke production . . . .

" To sum up, we are using excessive quantities of coal; we are providing inadequate heating in our houses; we are pouring out masses of soot and tar into the atmosphere. . . ."

That is the Committee's verdict on the four million houses built under the control of the Ministry of Health, after it had received the Newton report, and in spite of the continuing efforts of the National Smoke Abatement Society.

Smoke abatement has always been the blind spot of the Ministry of Health; I am glad to say that at long last there are signs that this is beginning to clear.

We found the position as regards research and development much more encouraging than it was in the days of the Newton report.

The most important developments had been in the gas and electricity industries; both had developed satisfactory (and of course smokeless) cookers and had sold them on a large scale, and important advances had been made in various other domestic appliances using gas and electricity. In 1938 15 per cent. of the heat used domestically was in the form of gas and electricity. The other 85 per cent. was burnt as solid fuel, and here progress had been painfully slow; the amount of reasearch had been utterly inadequate.

Turning to the post-war period we found that during the last two or three years there had been great progress, particularly on the part of private enterprise. There were some strong research organizations in existence among individual large firms in the gas and electricity industries, and a few were beginning to appear among manufacturers of solid fuel appliances; there were also several organizations of growing importance controlled by industries. What was perhaps even more encouraging, we found that at long last the Government was taking an active interest in research and development. During the war nothing had been done except a slight extension of the facilities of the Fuel Research Station, which did useful work on a tiny scale. Now things were different. At the instigation of the Ministry of Works, the D.S.I.R. had appointed a Committee on Heating and Ventilation under the chairmanship of the distinguished scientist Sir Alfred Egerton, whose report produced a mass of basic facts covering nearly all the scientific aspects of heating and ventilation. The Simon report may be regarded as an attempt to indicate how the data given in the Egerton report can best be applied in practice.

The Ministry of Works had also appointed a Scientific Advisory Council which was already at work in many directions, including an ambitious plan for the building of a number of working-class houses for large-scale testing in practice of different systems of heating and ventilation.

The Department of Scientific and Industrial Research was greatly expanding the Fuel Research Station, which had now become strong enough to give us invaluable help.

The Ministry of Fuel and Power had during the war developed a strong Fuel Efficiency Department, which helped us both on scientific and practical problems. And indeed the Ministry spared no pains to give us every possible facility and help.

The Atmospheric Pollution Research Committee under the D.S.I.R., and with the co-operation of over 50 Local Authorities, had published annual reports giving useful facts as to the amount of atmospheric pollution.

In short, we had advantages both as regards the scientific and technical evidence available, and the active interest and support of Government departments, which marked a complete revolution as compared with the experience of the Newton Committee.

The Committee concluded that there were three main lines of development for efficient, convenient, and smokeless domestic heating. The most important is to replace the bituminous coal used for domestic purposes by some smokeless solid fuel—anthracite, or some form of coke or briquette, to be burnt with an efficiency of not less than 40 per cent. The second is to increase the use of gas and electricity from 15 per cent. to, say, 30 per cent. of the total fuel consumed, in about twenty years. The third is to burn bituminous coal with increased efficiency and much less emission of smoke. These three developments depend on action by many different bodies in many different directions.

Two specially urgent developments are a cheap and efficient system of central heating for small houses, and (most important of all) a stove to burn bituminous coal smokelessly, or nearly smokelessly. I venture to predict that both these will be on the market at reasonable prices within the next few years.

District heating may prove to be an important line of advance, but there are serious difficulties. A dozen plants are likely to be at work within the next year or two.

Then the design of the house is most important ; there must be expansion of research and development in many directions ; unbiased technical information must be made easily available for local authorities, builders, architects and householders.

Our Committee made no less than 41 separate recommendations, and concluded that if these recommendations were reasonably followed it should be possible to secure that the 50 million tons of bituminous coal now burnt with a working efficiency of 20 per cent. should be replaced in 20 years by smokeless solid fuel, or by bituminous coal burnt smokelessly, or by gas, or by electricity, with an average coal economy efficiency of not less than 40 per cent.

This would render possible the following results :

The virtual abolition of domestic smoke.

Less labour and dirt in the house.

And either :

(*a*) Doubling the useful heat in the smaller houses at little or no greater cost to the householder and no increase in the consumption of coal, or

(*b*) An increase of 50 per cent. in the useful heat in the smaller houses with a substantial reduction in cost to the householder and a saving to the nation of perhaps ten million tons of coal per annum.

We pointed out that to achieve these results in twenty years meant an annual increase in the output of all kinds of smokeless solid fuels of one million tons. If the increase averages only 650,000 tons, then thirty years will be needed. Much depends on the vigour of successive Governments and of the National Coal Board. But the encouraging thing is that the Committee felt justified in suggesting that it should be possible to achieve these results in from twenty to thirty years.

Conclusion

That means that after thirty years there should be no more domestic smoke, and it is reasonable to assume that the rapid increase in the use of electricity for factories and the greatly improved combustion of the modern super power stations will mean the end of any serious emission of smoke from factories (though the problem of metallurgical furnaces may remain). So that we may look forward with reasonable confidence to the end of the smoke nuisance as a whole within thirty years.

Why has progress been so slow, especially as regards domestic smoke ? And why are we justified in believing that it is likely in future to be so rapid ?

There are four main reasons :

1. This country is blessed with large reserves of bituminous coal. This is our *most* important natural resource ; it

is also the perfect smoke producer. Up to World War I coal supplies were ample and very cheap, after World War I supplies were still ample but expensive and people began to think seriously of economy. Now coal is much more expensive and we are not producing enough to meet all our needs. The country has been forced to think hard and to act. The Ministry of Fuel was created and has been acting with great vigour, not primarily in order to abate the smoke but to promote economy and efficiency in the consumption of fuel, which by great good fortune comes to much the same thing.

2. Both the main lines of reform: the conversion of bituminous coal into smokeless solid fuel and the burning of bituminous coal smokelessly for different domestic purposes, require much scientific and technical work. The amount of such work has been utterly inadequate in the past; it has greatly expanded in many directions during the last few years. There is every reason to hope that it will shortly be on a really adequate scale.

3. Public Enemy No. 1 in the smoke abatement world has always been and is today the open coal fire. Lord Newton wrote in 1921: " Hitherto all criticisms of our present system have been met by indignant expostulation that the open fire is one of the sources of England's greatness and prosperity and that any attack on it is of the nature of high treason." Everybody hated smoke, everybody loved the open coal fire; the open coal fire won hands down. The Simon report sums up: " The open coal fire is sociable and pleasant; but it involves dirt and drudgery for the housewife; it wastes millions of tons of coal each year; and it is the chief sinner in rendering our cities unfit for human habitation by its smoke."

Scientific and technical brains have for the last few years been tackling the problems of the open coal fire; efficient, and often attractive, alternatives to the old-fashioned grate are already on the market, and beginning to be installed in large numbers. Progress has been slower than the Simon Committee hoped, but it is reasonable to say that in the battle against the old-fashioned open coal fire burning bituminous coal victory is at last in sight.

4. The fourth reason for confidence is that at last the Government is concerning itself actively with fuel economy and smoke abatement. Of the 41 recommendations of the Simon Committee, 27 were directly addressed to the Government: the Ministry of Fuel & Power, the Ministry of Works, the Ministry of Supply, the Ministry of Health. These Ministries have set up a Joint Standing Committee to follow up our recommendations; and having regard to the shortages of supplies, and the difficulties of carrying out quickly a revolution in domestic heating they are doing a good job. It is most encouraging to be able to record that the Ministry of Health in recent months has been fully co-operative, and that when, in 1948, the supply position justified it, the Minister immediately made it a firm condition of approval for all new housing projects that the main heating appliances should be selected from the list of appliances tested and approved by the Ministry of Fuel & Power.

In particular, we owe our thanks to the Ministry of Fuel & Power and the Ministry of Works, who are showing an initiative and energy in this field which represents a complete revolution as compared with the past, and to the D.S.I.R., which is rendering essential services on an increasing scale, mainly through the Fuel Research Station.

Finally, the three great national fuel producing corporations (Coal, Gas, Electricity) are of basic importance. On them lies the responsibility for producing each year more gas, more electricity, and above all a steadily and rapidly increasing quantity of smokeless solid fuel.

If my analysis is right, then it is clear what the main work that lies before the National Smoke Abatement Society in future will be: to endeavour to ensure that the Ministry of Fuel & Power and the Ministry of Works carry on their excellent work with their

present zeal and efficiency; to bring constant pressure to bear on the National Coal Board to reach the target of an additional million tons of smokeless solid fuel each year; and to make every effort to ensure that the Ministry of Health maintains its recent active interest in smoke abatement.

And, of course, a great deal of educational work is needed with local authorities, architects, builders and others; such work is likely to be more effective now than ever before because smoke abatement, without losing its idealism, has now become a practical proposition. Much important work lies before the National Smoke Abatement Society. We have now for the first time the necessary knowledge to solve the smoke problem, and the active good will of the Government. But there is still much ignorance and apathy, and success depends on a great deal of educational work. This can only be done by the National Smoke Abatement Society. Its progress in recent years has been gratifying, but I am sorry to say that its resources have not grown in proportion to the extension of its activities. I very much hope that the Society's appeal for funds which is now being launched will meet with a generous response.

What will it mean to our cities when we have finally abolished the smoke nuisance? May I again instance my own city of Manchester? This is my seventieth year as a citizen of Manchester; I have never lived anywhere else nor have I ever wanted to. It is a fine place to live and work in. It has its faults; the worst ones are due to the appalling cloud of smoke which hangs continually over the city during the winter.

Twenty-five years ago Lord Newton and I visited the Ruhr on behalf of the Smoke Abatement Committee and reported: "The most superficial investigation discloses an extraordinary contrast between such great industrial towns as Dusseldorf and Cologne, on the one hand, and any comparable British towns on the other. The former are pleasant and agreeable places of residence, and the best proof of their amenity is that even the richest citizens continue to live within the city boundaries, a practice which has long since been abandoned in British manufacturing towns."

This is, alas, true of Manchester. Indeed, it has long been true. So far back as 1850 the Stipendiary Magistrate said: "I do not live in Manchester now. Nobody does who can in anyway live out of it." During the whole of my life the vast majority of those who could afford it and whose work allowed it have gone to the pleasant surrounding country; most of them have ceased in effect to be citizens of Manchester or to take any interest in it except as a place to work in and to get out of. Today Manchester has a magnificent plan of reconstruction. One specially important part of the plan is the proposed cultural centre, including the University and the Hospital area and some of the main civic buildings: colleges, halls, theatres, and flats and houses in the near neighbourhood to house the professional class and the lovers of the higher things of life. When these buildings are erected, and many of them should be built in the next thirty years, only one thing more is necessary—clean air and sunshine. Then there will, I hope, be a reversal of the flight from the city, and the leading workers in Manchester will insist on living in their beautiful city and in enjoying the fully civilized life of society and cultural interests which only a great city can offer.

ADDRESS

by

ARTHUR BLENKINSOP, M.P.

Parliamentary Secretary, Ministry of Health

I was a little doubtful at one time in the early part of this week whether I should manage to get up and see you to-day because it had seemed possible that other matters of relatively minor importance might prevent me! But it did seem to me that there was a reasonably close connection between smoke and the problem of the dollar gap—one type of smoke, anyhow. And if in the course of my few remarks to you I can persuade your Society to widen the scope of its activities to concern itself with the abolition of tobacco smoke, or what I should like to call personal smoke, as well as industrial and domestic smoke, I should as a non-smoker myself, be very glad. I am indeed very glad to be with you because we do appreciate very much the value of the work that your Society has been doing for a long period of years against very real difficulties, and I read with great interest Lord Simon's Address to you and the encouraging and helpful remarks that he had to make, because he has indeed grown up with this problem, and he has fought the battle for smoke abatement for very many years, as indeed, of course, have many of your members, and we appreciate very much the work that he and others of your members have done over these last years, and we hope that we may now see the fruition of some of our efforts in these immediate years ahead.

I feel a certain amount of special and personal responsibility for this problem because I notice that Lord Simon in his Address mentioned that some of the earliest attempts to curb the smoke nuisance were in 1307, when there was an attempt—an abortive attempt—made in London to stop the smoke from dirty sea coal; coal that was exported from my city of Newcastle upon Tyne and sent down to London, and which caused the earliest, I think, smoke nuisance. Indeed, Newcastle has the doubtful privilege of having given the right to the Burghers in 1238 to dig coal round the Castle walls, and they started exporting coals down to London not very long after. I suppose you can date the problem of the smoke nuisance from about that time, so that we in Newcastle have a particular and personal responsibility for everything that happened after. It is only right therefore that we in Newcastle should do what we can to set a proper example and to move in a better direction in the future, as I think we are doing.

There is such a mistaken impression abroad that Newcastle is a dirty town, but it is not, and I am sure that the delegates who are here from Newcastle will support me. It is a very much maligned city, and it is now showing the way to that smokeless era that we all envisage.

I think it might be as well to start by confessing a few personal heresies

I have always associated in the past, without special thought, almost automatically, the question of smokelessness with the General Strike of 1926, and I tell you why. I remember very well that it was then that we could from our fine Newcastle for the first time see the sea, and it was then that we could see the beauties from Newcastle of the hills of lovely Northumberland for the first time in many years, and therefore to many of us, quite unconsciously, smoking factories still do mean working factories and still do mean employment for our people. I was interested in what the Minister of Fuel and Power said to you in your last Annual Conference, saying how anxious he was that we should break down that association of ideas. But it is an association that is common to very many of us, and it does show indeed how necessary is our propaganda for a smokeless future, and how great is the need for the work of your Society to try and break down these automatic reactions that are in the minds of a great many of the people in this country.

We are not yet used to the idea of the modern hygienic cleanliness of the factory site of to-day, and it will take us some time to realize that factories in modern industry do not necessarily mean smoke.

Finally, there is still in my mind, and I gather even more in my wife's, a lingering personal joy in the open fire. I feel I ought to confess all these personal heresies right at the start; not because I believe you will be personally interested in them, but because I know they are the heresies of most of us in this country if we confess them. It is, I think, true that there are very many in this country still, particularly, I think, in the North, who regard at least one open fire in the house as something of value and something of importance to cherish.

That is, I think, the common background of many of us, and it does indeed emphasize the need and the importance of the propaganda work of your Society and Local Authorities throughout the country. At the same time, it is true that to-day the major need—the issue of prime importance to us all—is the one of finding solutions to very immediate practical problems. We are broadly agreed, certainly here, and increasingly throughout the country, on the need to bring fresh air and cleanliness to our cities, both on the grounds of economy and the proper use of our very scarce resources to-day, and on the grounds of cleanliness and better life and health for our people. But we must, I think, turn our attention more and more to-day, as indeed you are, to the solution of the immediate practical problems that we must solve if we are to make further progress.

I would like first of all to say something about the domestic issue and then later I will say something on the subject of the industrial problem, which also is in your minds. Lord Simon did stress the need to pay special attention to the domestic grate and domestic appliances generally. I have always found it rather difficult to believe that some 60 or 70 per cent. of the smoke nuisance in the country is caused by the domestic grate. I frankly had thought, at any rate since the war, that the Minister of Fuel and Power had effectively helped to cure that problem by making sure that the domestic grate had not an awful lot of coal to burn! The other night I was travelling up North through Durham, and watched the multitude of blue streams of smoke joining together in the sky, forming a cloud round Durham Cathedral and Castle. I then decided that perhaps you were right, and that the major contribution of smoke nuisance is from the domestic grate, at any rate in our major coal-producing areas. It is right, therefore, that we should pay a very great deal of attention to this domestic problem and see what can be done to help cure it.

You know that during this last year we have, in the Ministry of Health, felt that we were able to insist that modern types of heating appliance should be installed in all new houses that are built, as the main heating unit of the house. Some people ask why we did not do this earlier. The answer, very simply, is that until the date we made

the requirement we were not satisfied that the production of new types was sufficient to meet the demand that would certainly arise. We are now satisfied that enough are being produced to meet the demand from Local Authorities for the houses now building, but there is certainly still no abundance of supplies, and it is not possible to insist that all domestic appliances shall be of the modern and approved patterns.

Why can we not insist also upon the subsidiary appliances, in bedrooms and the like, being of new improved patterns? There is not only the question of supply, but also the very real question of cost, to which Local Authorities simply must pay attention, as the problem of the cost of modern housing is continuously before us.

There is no doubt that the insistence upon new types for the main heating appliances of new houses is a very real step forward, and we are anxious, as always, to see a steady improvement in the abolition of smoke in our towns.

Furthermore, we are anxious to see as far as possible that old and out-of-date uneconomic grates are replaced by modern types, and we encourage Local Authorities to do what they can, as grates become inefficient, to insist upon replacement with modern types.

This will be a long term project. It will take many years to replace all the grates in our homes that are belching forth smoke into the sky throughout the country, but I think we are proceeding on the right lines, and we do believe, together with Lord Simon, that we shall be able to see a steady advance in these coming years. It must be related to the actual supply of grates available, and must be related to the problem of cost.

There is the further point that, as you know, we have recently passed through both Houses of Parliament a new Housing Act, which does make provision for improvement of old houses, and here again, where improvements are carried out, which often include improvements in heating appliances, we shall insist that new types installed shall be of improved patterns on the list of the Ministry of Fuel and Power.

We are trying to tackle this problem from three angles—the problem of new houses, the problem of gradually replacing old appliances in the older Council houses, and when improvements in housing are carried out under the new Housing Act.

This, of course, is not the whole of the problem. There is also the very real problem of the proper use of the new appliances, because it is perfectly true that some housewives find difficulty in using the new types of equipment effectively, and are apt to be discouraged if it does not work all right from the start, and to say that it is no more economical than the old types they used to have. We are, however, doing all we can to help, both ourselves and the Ministry of Fuel and Power, and a Sub-Committee of the Central Housing Advisory Committee is considering how best to help tenants with the care and maintenance of these appliances and of the other novel materials and equipment found in the modern house. Again there is the question of insulation of houses. We not only want to see that heat in the home is properly generated, making the most economical use of the fuel that we have, but we also want to see, as far as possible, that the heat is kept in the house, and there again, a great deal of work has been done to try and improve insulation of the new houses that are being built. This again is a problem involving the question of cost, but we have encouraged Local Authorities, so far as it can be reconciled with cost, to aim at the standards recommended by the Egerton Committee.

Personally, I am very much interested in the district heating schemes which some Local Authorities are carrying out. I hope that they will make good progress because I am very anxious to see the results. I believe and hope that they will be popular with tenants, and upon the results of these experiments we must determine our future policy. There is no doubt that district heating can offer a very great step

forward in the problem of smoke abatement.

Industrial pollution of the air covers a wide variety of quite separate and distinct problems, and I am not going to attempt this morning to discuss them in any great detail. Indeed, the new industrial estates that we see arising in different parts of the country are, of course, quite a revolution from the satanic mills and factories of the past that destroyed mind and body. But there is no doubt that for very many years to come we shall need to use these old factories, and I am afraid old machinery and equipment too. Our need for production in this country is urgent, and supplies of new equipment inevitably will be short. Delays of the war years and pressure to-day do mean that we shall be obliged to use comparatively inefficient equipment for some time to come, although we shall be only too happy to replace it as soon as possible ; a very serious problem for all of us, because it does mean that you are in danger of a steady increase of smoke emission when you are using out-of-date equipment, and when you are building up production to the greatest possible extent, and we all know that problem very well.

The direct control of the Ministry of Health over industrial pollution is restricted to the processes within the scope of Alkali Acts. A fresh draft order has been issued this year bringing further processes within the scope of the Acts. About one thousand works and two thousand processes are registered as likely to be dangerous or offensive.

I should like to say something about one particular problem in this field in which your Society is especially interested. This is the problem of dust emission from cement factories on Thames-side ; indeed you have a report before you on this subject. I took the opportunity a few weeks ago of going down to Thames-side and looking through some of the cement factories in that area and seeing for myself something of the problem that exists there. It is, of course, true that the amount of settlement of dust in that area has been very great indeed. I think it is fair to say that you do not have to be there very long to see that there has been a very real improvement during the last year or 18 months. Your own Society has been making its very careful investigations, and we have been doing our utmost, together with the Ministry of Supply, to help to check the emission of dust in these areas. Of course, it was quite wrong that houses should be built so near to cement factories, and it was a shocking thing to me to see some of the houses right in the middle of a great ring of cement factories, which should never be there at all. We have got to confess that in the very necessity of things there will be a certain amount of dust emission from cement factories for many years to come. We must do our utmost to check it as much as we can. We are receiving the full co-operation of the Companies concerned in trying to deal with this nuisance in that area. I am quite satisfied that they have made a very real change in this last year, and I feel sure that with new plant and equipment we shall see further improvement during these coming months. We have got to confess the fact, however, that with the pressure on production and the concentration of 50 per cent. of the total cement production in that area, dust emission will still be a nuisance.

There is no doubt that the best results in the whole problem of industrial smoke nuisance can be achieved by effective co-operation between Local Authorities and industry, because better fuel practice is in the interests of both parties. It is an economy to industry, and it can be a great contribution to the better health and welfare of the community.

You have been discussing some suggestions for future legislation. It is suggested that we introduce a little too much legislation as it is. I do not subscribe to this of course but it has been suggested. We must be careful in considering any proposals that you may make to be satisfied that indeed it would help us forward if there were some power to insist on prior approval

of industrial furnaces. We should wish to be convinced of the practical value of such a step, and would like to have experience of the working of local Acts which are already in operation. I myself have been very interested in the proposals that have been put forward for the establishment of smokeless zones. I personally welcome this development, and hope to see it developed through the country. Some people argue that smoke drifting in from outside areas will spoil the value of the schemes, and will defeat the object of getting willing co-operation of firms and domestic users in the limited smokeless areas. Personally, I do not believe that will be so. I believe it should rather reinforce the demand from the smokeless zone for the steady extension of its area, and that is what I believe we should work towards. We must confess the fact that the problem is long-term, and we cannot hope to overcome this problem in a short period. If it is a long-term problem then we must try to carry the general public with us by showing steady advance from year to year. The development of the smokeless zone does offer the best hope of this.

Now, both the Ministry of Fuel and Power and ourselves will continue, I assure you, to do all we can to help, but we know that undoubtedly the greatest contribution can be made locally by the Local Authorities supported by the keen and well-informed public opinion in the area.

I would finally repeat to you some lines of William Morris which are apt and proper to-day :

"Forget six counties overhung with smoke,
Forget the snorting steam and piston stroke,
Forget the spreading of the hideous town,
Think rather of the pack-horse on the down,
And dream of London, small and white and clean,
The clear Thames bordered by its garden green."

PROGRESS REPORTS

A Guide to Organization

This contribution is made by the Society in answer to requests for a statement explaining how the smoke prevention movement, in its broadest sense, is organized, and what the relationships are between its different sections. It seemed that the best way of making this explanation was by a diagrammatic chart, which has therefore been prepared and is reproduced with these papers. The chart is more in the nature of a situation report than a progress report, but it is believed that it will be of considerable interest to many, even if only for the picture it gives of the number of organizations concerned with atmospheric pollution in one respect or another. As far as the Society itself is concerned we feel that it will be useful in indicating how numerous and varied are our interests and contacts.

One point may be referred to in particular : we find, from time to time, some confusion about the nature of and the differences in identity between the Society's Divisional Councils and the Regional Committees of the Local Authorities. The latter are purely Local Authority bodies ; the Society and its Divisions include Local Authorities, other bodies of many kinds, and individual members.

The lines linking the different organizations and groups represent a variety of forms of relationship, which could not be distinguished without making the chart too complicated. In some cases the links are those of membership, in some of devolution, and in others they represent some formal or informal kind of contact or co-operation. At first sight the chart may seem complicated enough, but it could easily have been more so. For example, the " Fuel Industries and Associations " could with advantage have been divided into its many component parts, and it would have been useful to include some addresses and similar details. Such information can however be found elsewhere or can be obtained from the Society on request.—*N.S.A.S.*

National Survey of the Sources and Incidence of Atmospheric Pollution

At the beginning of 1948, following a resolution of the Edinburgh Conference, the Society carried out a survey of the sources and incidence of atmospheric pollution by addressing a questionnaire to some 1,800 local authorities of whom nearly 800 replied.

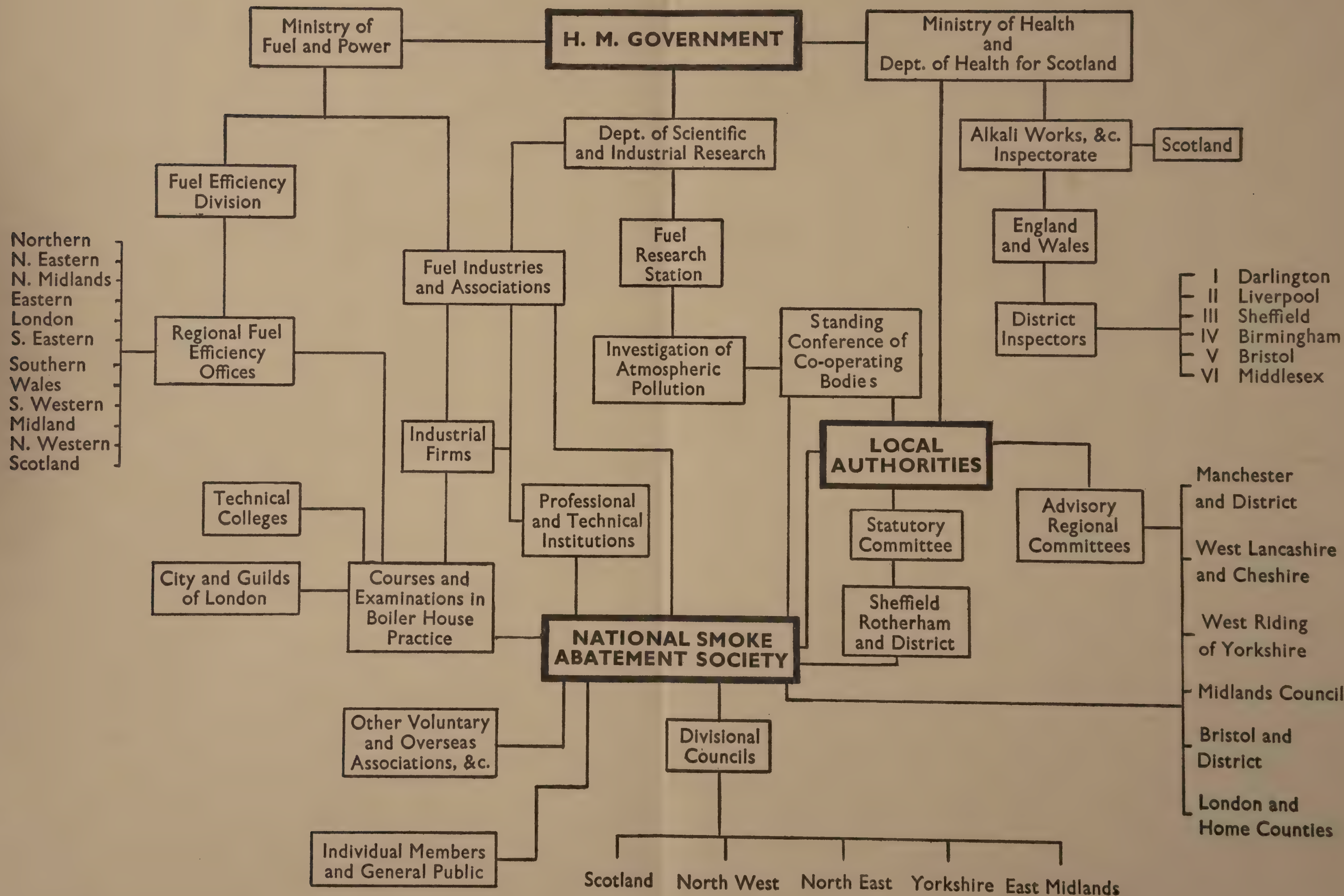
An interim report was given at the Cheltenham Conference based mainly on Part I of the survey. Part II of the survey, which tabulated the potential sources of pollution in detail, has been examined and collated as it refers to the areas of the Divisions of the Society.

Part II of the survey was not uniformly interpreted by all local authorities and it is not possible to analyse it strictly on a numerical basis. It was considered that Divisional Councils might be in a better position to appreciate the detail of the return than would be possible at headquarters, and several Divisions of the Society have undertaken an examination of the survey for their own area.

In the meantime, the survey has been used to extract information that Divisional Councils have required and it remains available as a source of information to any member of the Society. —*N.S.A.S.*

SMOKE PREVENTION ORGANIZATION - Great Britain 1949

(Note : The Chart shows only the principal organizations and groups and their most relevant links).



Towards New Legislation

At the end of 1947, after approval in conference, the Society published for discussion its tentative proposals for new legislation for the prevention of industrial smoke, and submitted them for comment and criticism to Associations of local authorities, Smoke Abatement Committees, the Federation of British Industries, the Trade Union Congress, and others.

These proposals involved an amendment of the Public Health Acts, 1936, to enable local authorities to make byelaws empowering them to require (a) the submission to them, for their approval, of plans of all proposed new or altered fuel-burning installations, (b) the maintenance and correct operation of the plant, (c) the registration of fuel-burning plant, and (d) the registration of firemen.

There was general approval of these proposals, but some criticism was directed to the following points:

(*a*) Prior approval was generally approved, but some doubt was expressed as to whether the approval should be given by the local authority, by a regional, or by a central organization, such as the Ministry of Fuel and Power.

While this discussion was in progress the position became complicated by the passage of a number of local Acts of Parliament conferring on local authorities varying powers for the prior approval of fuel-burning plant, reference to which is made in some of the accompanying Progress Reports.

The Minister of Fuel and Power, on 14th December, 1948, very kindly received a deputation from the Society, and expressed his willingness to receive from the Society a memorandum on future legislation. The Technical Committee, to which this request was referred by the Executive Council, felt that they would be unable to frame a precise memorandum until they had correlated the Society's original proposals with evidence on the manner in which the new local Acts were operating. Officers of these authorities have been interviewed and their views on the practical application of their own new legislation, together with the comments on the Society's original proposals for new byelaw powers, raise the following questions:

(*a*) Should future powers be conferred on local authorities by byelaws made under amended sections of the Public Health Acts, 1936, or should they be first by way of local, and possibly later, by general legislation?

(*b*) If through byelaws, should their adoption be obligatory or permissive?

(*c*) Should fuel-burning plant be approved by local authorities, by regional organizations, or by a Central department?

(*d*) Should submission of plans be optional or compulsory?

(*e*) In the event of an appeal against a decision of a local or other authority, should it be to a Court of Summary Jurisdiction, a Government Department or other body?

(*f*) To what extent can the powers conferred by the Town and Country Planning Act, 1947 (section 14(i)) be used by local authorities to prevent smoke?

(*g*) Should the powers for the establishment of smokeless zones, and any other smoke prevention measures required (e.g., for the control of the sale and use of bituminous coal, as in new American smoke prevention legislation) be included in any proposed general legislation, so that a comprehensive national code for the progressive abolition of smoke can be secured?

(*h*) How will the plant belonging to Government departments, and that of the statutory corporations recently established to control the "nationalized" industries fit into any scheme for the control of industrial smoke?

There is such a considerable weight of opinion against registration of firemen unless registration is limited to those who have obtained a certificate of competence, that this question should probably be deferred until some national scheme of training and certification has

been formulated. This is at present being explored by the Society.

Finally, the fact that we have arrived at the stage of formulating and seeking to answer the questions listed down—not one which could have been thought of ten years ago—is in itself a sign of the rapid progress being made towards smoke prevention. It will be agreed that in tackling the problems involved, many of which are difficult and complex, the Society is entering on a phase of its work of the greatest importance, in which the co-operation, experience, and studies of its local authority and other members will be most valuable. —*N.S.A.S.*

Prior Approval in Salford

The Local Act in which the "prior approval" scheme is outlined received Parliamentary sanction in July, 1948. It is applicable to steam-raising furnaces only and makes it an offence to install such a furnace which is not so far as practicable, capable of being continuously operated without emitting smoke.

Persons proposing to install a furnace are granted the prerogative of submitting plans, specifications and other information of the proposed furnace to the Corporation and requiring them within six weeks to state whether they are or are not satisfied that the furnaces will be capable of being so operated. Before serving notice to the effect that they are not satisfied the Corporation is required to consult with the Minister of Fuel, and in making a decision regard must be had to cost and local conditions and circumstances.

To give effect to the scheme a panel of three, representing the Medical Officer of Health, the Corporation Engineering Department and the Ministry of Fuel has been formed to consider proposals submitted and to make recommendations.

The large steam-raisers in the city have been informed of the scheme, but up to date no proposals have been submitted, and no new furnace installations have come to the knowledge of the department. Work on two installations was in progress at the time the Act came into operation but had proceeded too far for the "prior approval" scheme to be applied.

It came to the knowledge of the Smoke Inspector in March that one firm were contemplating installing a new boiler and the firm had been written to, directing special attention to the new legislation. Latest information from them is that a decision has not yet been arrived at, but that the proposals will be submitted for approval if it is decided to proceed with them.—*Dr. J. L. Burn, Medical Officer of Health.*

Prior Approval and Other Progress in Coventry

Since the introduction of the Coventry Corporation Act, 1948, with its provisions for the voluntary submission of plans of proposed steam generating plant for "prior approval," it has been found that the limited relief conferred has, judging from the response and interest aroused, been of sufficient attraction and inducement to auger well for the future working of the scheme. Co-operation of factory managements, industrial and other architects has been solicited by circular letter, and a specimen form of submission of relevant details has also been published. Liaison with the local building byelaws authority has been established in order that where plans of proposed factories of extensions are deposited, investigations may be made with a view to future smoke

prevention. In several instances building owners of proposed factories have been invited to take advantage of the relief referred to in the Act, and in every case co-operation has resulted and the advice of the qualified inspectors gratefully accepted. Application has been made to the Ministry of Health for permission to operate the provisions of the Act concerning the initial "smokeless zone" which includes a large area on which central rebuilding has recently commenced.

Other recent routine activities have included the installation of proprietary mechanical stoking equipment to two existing Lancashire boilers at what was previously a municipal general hospital; the installation of thermostatically controlled electrically operated underfeed stokers to two existing sectional boilers at a public baths; replacement of three small obsolete vertical boilers at a hospital with a modern mechanically stoked Economic boiler. At industrial concerns in the City further official intervention resulted in the removal of an obsolete Cornish boiler at a textile factory and substitution with gas-fired plant; removal of two inadequate hand-fired Economic boilers at a large laundry and the installation of one large self-contained mechanically stoked double-pass Economic type boiler; adaptation of a large pulverized fuel plant at an extensive machine tool works in order to improve the efficiency of the grit-arresting apparatus; installation of a specially designed dust-arresting plant at an aluminium refinery; elimination of a persistent smoke nuisance from a centrally-situated flour mill as the result of complete electrification of the plant. Advice and instruction to stokers and engineers continues to be given by the specialist inspectorate during routine visits to factories, etc.

In order to obtain widespread continuous measurement of the extent of aerial pollution in the City, a number of additional stations are being established. The Fuel Research Station of the Department of Scientific and Industrial Research has been approached for advice regarding the location of the stations and the methods of measurement of atmospheric pollution.
—*W. Beaumont, Chief Sanitary Inspector.*

Prior Approval in Preston

Experience in the working of the appropriate smoke prevention clauses of the Preston Corporation Act is being gained slowly. Only three plans have been submitted since the last Progress Report.

In the first instance, where an overloaded steam raising plant was the source of repeated complaints of smoke pollution the firm decided to build a new boiler house with larger plant. The plan was approved without modification, the new plant is in operation and the complaints of smoke nuisance have ceased.

In the second instance the plan has been approved after consultation with the architect but the erection of plant is not yet complete.

In the third instance in which little or no information was supplied, further details, in accordance with the provision of the clause, have been asked for.

In another instance where a firm asked for information regarding the application of the Act to the execution of repairs to damaged premises it was ruled that the Act did not apply but nevertheless the consulting engineers co-operated on a voluntary basis with the department before and during the period of carrying out the repairs.

Experience of the operation of the smoke prevention clauses is still very limited but it is apparent that on the one hand they are not sufficiently comprehensive in scope and that on the other, firms and their consultants are ready to co-operate with the department in eliminating possible trouble in the future when its solution is often so much more difficult and costly.—*E. Owen, Chief Sanitary Inspector.*

Prior Approval in Manchester

The powers contained in section 36 of the Manchester Corporation Act, 1946, prohibit the installation in any building, of any furnace for steam raising or for any manufacturing or trade process unless such furnace is, so far as practicable, capable of being operated continuously without emitting smoke.

"Prior approval" of furnaces is *not* made obligatory by this section, which also provides that a person proposing to install a furnace *may* submit plans and proposals to the Corporation who are required to give a decision. Furnaces approved under this requirement are excluded from the application of penalties under the section.

Only a few installations to which the section applies were reported to the Health Department during 1948. These installations have been of a minor character and smokeless operation was readily schieved. A number of new industrial furnaces were installed without the submission of plans to the Corporation. They were found to comply with the requirments of the Act as regards smokeless operation.

Close co-operation has been maintained with the City Architect to ensure that the Health Department is advised of building plans which indicate furnace installations and architects are reminded of the smoke provisions of the Act. Most of these installations are central heating furnaces however. Industrialists in the city are very willing to co-operate in meeting the requirements of the Act.

The Corporation is at present considering the desirability of including in their next parliamentary bill, a suitable amending clause to bring within the scope of section 36 of the Act, certain types of newly installed furnace to which the section is not now applicable. The section does not apply to newly installed furnaces used only for heating buildings, unless steam is raised in the furnaces. Many furnaces for central heating by hot water have been installed in the City since the 1946 Act came into operation.

Other types of furnace which are excluded from the powers of section 36 are those used for hot water heating or cooking, other than for trade processes, in institutions, schools, churches, and canteens, etc. It also appears that it would be advantageous to substitute the word "premises" for "building" in the section, so as to include furnaces installed in yards, such as bakehouse furnaces, and also steam cranes on land, usually in connection with buildings.

Section 36 is also restrictive, in that though furnaces may be capable of continuous smokeless operation when installed, any smoke emission after installation is subject only to action under the smoke abatement provisions of the Public Health Act, 1936. The section requires amendment so that newly installed furnaces shall not emit any smoke after installation.—*Dr. C. Metcalfe Brown, Medical officer of Health.*

Prior Approval in Birmingham

Prior approval of fuel-burning plant has long been the unofficial policy, but, until after July, 1948, this was by way of a "gentlemen's agreement," under which the City Engineer and Surveyor forwarded plans of all new structures or extensions, incorporating boiler or furnace plant, for the observations of the Medical Officer of Health. Such an arrangement is, on paper, an excellent one, but, in practice, not infallible. Plans may sometimes slip through without reference to the Medical Officer of Health, while extensions may come to the notice of the Public Works Department when already a *fait accompli*.

There is, moreover, a weakness inherent in such an arrangement, that the only means of effecting modification or alteration of an unsatisfactory proposal must be by persuasion if plans are otherwise satisfactory.

It was for this reason that powers were sought to include an obligatory clause in a corporation bill submitted to Parliament in 1947. This clause was drafted on lines similar to the Preston clause, except that adjudication was to be in the hands of a member of the Institute of Fuel, rather than the nominee of government department such as the Ministry of Fuel.

Manchester and Dudley had by this time acquired only a voluntary clause, so that strong opposition was anticipated. This materialised from the representatives of big industry, the grounds for objection being, however, unwarranted and ridiculous. These may be referred to briefly, with appropriate comment :—

1. There is no justification for any claim that inspection of plans would tend to retard progress by control of design and it is a most unfair and unjustifiable criticism that to submit details of fuel-burning plant must inevitably disclose trade secrets. There could be no such fear with boiler plant, and if a furnace were designed to burn only solid smokeless fuel, or were to be operated by gas or electricity, surely that would constitute sufficient information and be accepted unconditionally.

2. The plea that works engineers are the last word in expert opinion on the question of smoke prevention is scarcely supported by the observation in industrial areas. Some undoubtedly are, but by no means all.

The fully qualified Smoke Inspector, however, is rather more knowledgeable than some representatives of big industry would seem to believe, and it is no exaggeration to say that these same Inspectors have little difficulty, when in conference with works engineers during the investigation of an established nuisance, in discussing the problem with these same experts and in suggesting a sound method of eliminating further nuisance.

3. There need, moreover, be no delay, as a result of inspection and consultation, on the submission of proposals to the Medical Officer of Health : one week should suffice.

By these objections, big business virtually denied the existing will to co-operate with the local authority, a will to co-operate which has been for many years a feature of the relationship in Birmingham between the Smoke Inspector and the individual industrialist. One must also regret an attitude which chose to forget that, for every large works, there are a hundred or more small premises without expert opinion behind them, and consistently the greater offenders in creating smoke nuisance.

Objection carried the day, however, and we have a voluntary clause, which has yet to prove of value. No plans have so far been submitted to the Public Health Department under Section 46 of the Birmingham Corporation Act, 1948. The " gentlemen's agreement " remains, however, and has become more effective with the support of the Town and Country Planning legislation, while we continue to operate the existing smoke law, the Public Health Act, 1936, and a 3-minute black smoke byelaw.—*Dr. W. R. Martine, Senior Assistant Medical Officer of Health.*

City of London: Byelaws for Prior Approval

The City of London (Various Powers) Act, 1946, Sec. 14, provides that the power of the Common Council to make byelaws under Sec. 151 (Byelaws as to Smoke) of the Public Health (London) Act, 1936,

shall be extended to include power to make byelaws requiring in the case of new buildings and in the case of substantial alterations in the arrangements for heating in any existing building, the provision, to the satisfaction of the Corporation, of such arrangements for heating as are calculated to prevent or reduce to a minimum the emission of visible smoke.

Draft byelaws were framed and were submitted to the Ministry of Health for approval in March, 1948. These draft byelaws required the submission to the Corporation of plans, sections and written particulars of new heating installations or substantial alterations to existing plants; empowered the Corporation to issue, refuse or withdraw certificates of approval valid for five years, the applicants being given full opportunity to state their case; and provided penalties for operating new or substantially altered heating arrangements without obtaining prior approval, or failing to operate approved arrangements efficiently.

No attempt was made to specify any constructional or mechanical requirements in heating appliances; it was simply laid down that the Corporation must be satisfied that the arrangements proposed were calculated to prevent, or reduce to a minimum, the emission of visible smoke.

The Ministry first suggested that owing to the difficult coal supply position and particularly the shortage of smokeless fuel, the present time was not opportune for the making of such byelaws. The Corporation, having in mind the re-building of the extensive devastated areas of the City, requested discussion of the problem at senior officer level.

After discussion between the officers of the Ministry and the Corporation, the Ministry intimated that they would be prepared to consider, with a view to confirmation, a series of byelaws which were not open to criticism on the grounds that they were unreasonable in the light of existing conditions as to fuel supplies or that they failed to give adequate and specific guidance as to the arrangements which would satisfy their requirements. The Ministry contended that the draft byelaws were not sufficiently specific as to the requirements which would satisfy the Corporation.

A further meeting between officers was arranged. The officers of the Corporation contended that it was not practicable, or indeed desirable in the interests of progress, to be absolutely specific in regard to the details of construction of fuel burning appliances. They agreed that, though Local Authorities might reasonably be expected to have on their staff officers capable of inspecting appliances as to the efficiency of operation and maintenance, many such Authorities might not have officers competent to adjudicate on plans, sections and written particulars of proposed installations. They therefore suggested that the Ministry of Fuel and Power should have on their regional staffs, officers with the necessary qualifications and experience to whom such plans, etc., could be submitted for observations and criticism. If such officers were available the Corporation would be prepared to submit plans, relating to industrial plants, to them and to make the issue of certificates of approval dependent on their report. In the matter of appliances for domestic heating, or the heating of offices, blocks of flats, hotels, etc., it was submitted that the officers of the Corporation were themselves competent to approve or reject proposals.

The Ministry undertook to discuss these suggestions with the Ministry of Fuel and Power, and there the matter rests at the present time.

—Dr. C. F. White, Medical Officer of Health

Smokeless Zones in Salford

A survey of premises in the three areas proposed for treatment as "smokeless zones" was commenced in March and has just been completed. The

information gleaned is being analysed preparatory to presentation of a report to the Health Committee and the City Council.

The following particulars are now available :

	Dwelling Houses	*Annual Fuel Consumption* Coal		*Industrial Commercial and other buildings*	*Annual Fuel Consumption* Coal		
		Coal	*Smokeless Solid Fuel*		*Coal*	*Smokeless Solid Fuel*	*Oil*
		tons	*tons*		*tons*	*tons*	*galls.*
Zone I	2,155	5,238	282	42	20,558	73½	—
Zone II	1,880	3,976	594	23	26	647	750
Zone III	878	2,052	492	24	6	37	6,000
Totals	4,913	11,266	1,368	89	20,590	757½	6,750

Enquiry has been made of the Ministry of Fuel of the extent to which the 12,000 tons of coal burned in the 4,913 houses can be replaced by low volatile coal and carbonized fuel other than coke and a reply is awaited.

Of the 20,000 tons of coal burned in industrial, commercial and other buildings, it is estimated that 19,000 tons will be used on four new watertube boilers expected to be brought into use in September this year to replace six Lancashire boilers from which a serious black smoke and grit nuisance now arises. It is difficult to see how exemption from the smokeless zone conditions can be refused in this case, if objection is made.

Volumetric measurement of smoke concentration at five points in or near the proposed zones is now being carried out for the purpose of detecting any improvement after the zones are established. –*Dr. J. L. Burn, Medical Officer of Health.*

Smokeless Zones in Manchester

In section 35 of their local Act of 1946, Manchester Corporation secured powers to prescribe a smokeless area in part of the central district of the City. This section also enables further smokeless areas to be prescribed with the consent of the Minister of Health, after local enquiry.

The central area was originally surveyed in 1938 as a basis for securing the present powers. During the ensuing period however, there have been considerable changes in the area and difficulties with regard to smokeless fuels and apparatus have made it desirable to defer the operation of the Corporation's powers. Some improvement in the fuel etc. situation towards the end of 1948 has enabled the Corporation to give further consideration to the matter and during 1949 a further detailed survey of the area concerned has been made as a step towards the implementation of the provisions of section 35 of the Act.

Certain implications which have arisen as a result of the survey are at present being examined. — *Dr. C. Metcalfe Brown, Medical Officer of Health.*

Dust Nuisance from Cement Works Thames-side Area

At the Conference held in Edinburgh in 1947 attention was called to the nuisance in the Thames-side area due to the emission of dust from Cement Works.

At the Conference held at Cheltenham last year a report was submitted showing that a Conference of the Local Authorities in the Thames-side area had established an Investigation Committee to consider what steps could be taken to abate the nuisance and to collect evidence of the deleterious effect of the nuisance upon the health of the people, upon crops, and live stock.

The report stated that evidence had been obtained that growers of fruit did sustain a loss owing to crops looking shabby and requiring additional washing to make them fit for market but no evidence could be obtained showing the actual cash loss per acre.

The Investigation Committee has now completed its enquiries and a further Conference of Local Authorities and other interested bodies has been held to consider its Report.

The Society has a copy of the Report and of the proceedings and were represented at the Conference.

Briefly the position is that further evidence was obtained of the deleterious effect upon crops of all kinds, upon livestock in dry seasons and upon glasshouses. In the latter case evidence was obtained that in certain cases the Cement Companies either themselves paid periodically for the cleaning of the glass, or had it cleaned for the Owners. No actual loss in terms of money could be obtained.

No medical evidence could be obtained that the health of the inhabitants of the area was adversely affected but it was stated that there is a high incidence of carcinoma of the lung in the South Eastern area of the country. The Local Authorities are asking the Registrar General to provide details of deaths from this cause tabulated by sex and age during the years 1949-1953 and the standardized mortality ratios worked out from the population figures obtained from the Census of 1951.

Improvements in the supply of dust extraction plant have been considerable and the subsequent tests obtained by the petri dishes show that the deposits of dust have been greatly reduced.

It was, however, ascertained that there is no machinery yet devised which is 100 per cent. efficient and that 95 per cent. was probably the best that could be hoped for at the present time.

It will be remembered that the Chief Alkali Inspector of the Ministry of Health stated at the Cheltenham Conference that about half the total cement production of this country was concentrated in the Thames-side area.

It has, therefore, to be recognised that a 95 per cent. efficiency of plant leaves a margin of 5 per cent. and this amount will still cause a nuisance, but if this standard is reached and maintained it will considerably lessen the nuisance which has been so pronounced in recent years and at times intolerable.

The Investigation Committee recommended and the Conference approved the report being submitted to the Minister of Health, and pressure brought to bear upon the Government :

(1) for sufficient steel to be released to enable precipitation plant to be maintained in proper working order so that each factory should reduce the emission of dust to a maximum of not more than 5 per cent.
(2) to insist that efficient Electrostatic precipitation plant is installed in all kilns at all the works and to see that sufficient steel is available for the manufacture of spare parts.
(3) for legislation compelling factory owners to carry out such measures

as are necessary to prevent pollution of the atmosphere either by an amendment of the Public Health Act, 1936, or the Alkali, etc., Works Regulation Act, 1906.

The Members of Parliament for the Thames-side area are being requested to make arrangements for the Investigation Committee to meet the Minister of Health and Minister of Supply and to discuss the report and recommendations of the Conference with the two Ministers.

To summarise, the Investigation Committee have succeeded in focussing attention on the nuisance and with the assistance of the Members of Parliament have accelerated the release of steel to enable the precipitation plants to be brought to a state of efficiency, and whilst the nuisance will never be eliminated so long as the manufacture of cement continues, it has been considerably reduced.

Many requests for copies of the Committee's Report have come from various parts of the country.

The latest information received is that it has been arranged for a deputation of representatives of the Investigations Committee to meet the Parliamentary Secretary to the Ministry of Health, Mr. A. Blenkinsop, M.P., on 6th October. A representative of the Ministry of Supply will also be present. —*E. James, Hon. Secretary, Investigation Committee.*

The Carrington Area Investigation

This investigation was commenced by a group of local authorities in South-East Lancashire and North-East Cheshire in co-operation with the Department of Scientific and Industrial Research, in order to ascertain the extent of atmospheric pollution prior to, and as a result of industrial developments in the Carrington-Partington area of Cheshire.

In this area, which is about 7½ miles south-west of Manchester, there is in course of erection a power station with an ultimate capacity of 400,000 kilowatts. The first development of a large scale plant for "cracking" petroleum by the "Caterole" process is also in production in the same area.

The power station will incorporate electrostatic precipitation and as a result of representations it has been arranged that information on pollution before and after the power station commence generation will be submitted to the Electricity Authority to support the claim that gas washing plant should be installed.

As regards the "Caterole" plant, the "tail" gases are being taken by the North-West Gas Board at their Partington Gas Works and sulphur is removed in this process.

The investigation is of concurrent importance to one of the local authorities concerned because of persistent nuisance from tar distilling plant in their area. The observations have been undertaken by the Manchester and District Regional Smoke Abatement Committee on behalf of the local authorities and were commenced in August, 1948.

22 lead peroxide apparatuses and 6 deposit gauges were originally proposed and of these, 19 lead peroxide apparatuses and 5 deposit gauges are in operation. Further consideration has shown the desirability of extending the observations by installing 2 additional lead peroxide cylinders and 2 deposit gauges, particularly in the industrial area of Trafford Park.

The whole of the 24 lead peroxide apparatuses and 8 deposit gauges are expected to be in use in October, 1949. The apparatus has been installed on a "grid" principle spaced at distances of roughly one mile, over an area of approximately 36 square miles.

This area is partly industrialized, partly residential and partly rural in character. Widely differing types of sites are in use, consisting of farms, sewage works, public parks, public

buildings, schools, gas works, an airport and an existing power station. Considerable interest is being shown by local farmers in rural parts of the area.

Since August, 1948, the deposited matter has ranged from 10 to 24 tons per square mile, and SO_2 from 0.70 to 7.04 mgm./100 sq. cm./day during the whole period. The investigation is intended to continue for at least 5 years and as only 12 months' results have been obtained they have not, as yet, any true significance.

The effects of pollution in this area on plant physiology are also being investigated. The interest of the Department of Botany of the University of Manchester and of the Agricultural Research Council has been secured and a full time research assistant has been appointed. A study will be made of the effects of atmospheric pollution on pasturage mixtures used on farms in districts to the north and north-west of Manchester and also on plant life in districts adjoining the Carrington-Partington area. This special investigation is intended to be on a more thorough scale than that undertaken some years ago in Leeds by Cohen and Ruston.

It will be of great value, not only as a piece of scientific research, but in ultimately assisting the local authorities concerned, in their efforts to prevent the continued emission of sulphurous gases from the power station at Carrington.

The investigation will include amongst other matters, the effects on germinating power, and elimination of such factors as soil, etc. It is primarily concerned with the deleterious effect of atmospheric SO_2 on plant life and much of the work will be carried out at the University's experimental grounds.

The cost of this investigation is being subsidized by the University of Manchester, the Agricultural Research Council and the Manchester and District Regional Smoke Abatement Committee (on behalf of the Boroughs of Altrincham, Sale, Stretford, the Urban Districts of Irlam, Hale, Urmston, and the Rural District of Bucklow). These local authorities are sharing the whole expenses of the chemical investigation which is being undertaken on their behalf by the Manchester and Disrict Regional Smoke Abatement Committe.
—*Dr. C. Metcalfe Brown, Hon. Secretary Manchester and District Regional Smoke Abatement Committee.*

Progress with Gas and Gas Coke

Since 1938 the consumption of gas in the home has increased by 44 per cent. and in industry by 70 per cent. Increased use of gas means larger supplies of coke, the gas industry's second smokeless fuel.

Gas and coke, used in conjunction, are giving new homes a smokeless fuel service and a higher standard of comfort. To provide this fuel service, which also has a very low "coal requirement," the use of gas is recommended for cooking, home laundry, background heating, summer water heating and refrigeration, while coke warms the living room in a gas-ignited fire and heats the water in winter.

Recent Developments

Many improvements have been made in the design of gas and coke appliances for the above needs and research is active to raise efficiencies even higher and to reduce consumptions and running costs. Among these developments may be mentioned the convector gas fire for long period heating, which has an overall efficiency about one-third greater than that of the normal radiant fire; improved designs in portable and background gas heaters; the use of more efficient burners on cookers; and a gas water heater, incorporating a circulator and 15-gallon storage tank, which will fit under the draining board. A back boiler is being developed in which, by means of a simple burner attachment, gas can take over from coke for summer water heating; a similar "two-fuel" domestic boiler is also being developed

to change over from coke to gas or vice versa at the user's will.

Reducing Industrial Smoke

In the industrial field the increasing use of gas-fired plant has has and is having an appreciable effect on smoke pollution. The bread baking trade is replacing coal-fired ovens by gas-fired equipment at a rate that is taxing the resources of the manufacturers of plant—in the last two years the use of gas for baking has doubled in the area of one large London gas undertaking, and this is typical of the trend throughout the country. In Sheffield the steel industry is using about twice the quantity of gas it consumed before the war and the present annual consumption does work that would need nearly 700,000 tons of coal in coal-fired furnaces. In the pottery trade in Stoke-on-Trent the consumption of gas has risen from under 7½ million cubic feet in 1932 to an annual consumption of 300 million cubic feet.

In the large-scale applications of coke, developments in automatic stoking have increased the efficiency of coke-fired central heating plant; and the use of coke in agriculture for grass and grass drying, glasshouse heating, etc., is increasing.—*The Gas Council*

Progress with Electricity

Atmospheric pollution is admittedly one of the greatest evils that menace our national health. The polluted atmosphere of many of our big towns and busy industrial centres is, of course, the legacy of previous generations. They permitted industrial development to proceed without control and with little thought of ultimate consequences.

Modern industry, to quite a considerable extent, has ceased to offend—large factories need no longer be built complete with smoke stack and boilers for producing their own power—they can rely on the electric drive which is clean and convenient and highly efficient. But it is by the increased use of electricity in the home that the battle against smoke is being won. More and more households are using electricity for water heating, cooking and occasional space heating. In addition, large numbers of inefficient smoke-producing stoves are being eliminated, by the practice of municipalities, which is extending, of installing communal laundries containing groups of electric washing machines.

The newer housing estates and blocks of flats in the larger towns, if not all-electric, are mainly electric, and as more generating stations are completed to satisfy the demand for electricity so can we expect to move nearer to the smokeless age.

During the worst periods of fog in the metropolis last winter it was interesting to observe that, without any attempt at planning, comparatively smokeless zones were appearing in the more central areas. These zones incidentally were probably more highly electrified than the outer suburbs where the retention of the older types of open fire burning ordinary household coal was clearly seen by the thicker yellow fog which covered them.

There is no doubt that with the greater use of smokeless fuels and the extended application of electricity, these new smokeless zones are pointing the way to the ideal towards which the National Smoke Abatement Society has urged the public for so many years.

Power Station Progress

Official returns of electricity consumption show that domestic consumers today are using twice as much electricity than before the war, while factories' consumption during that same time has increased by 80 per cent. The electric supply industry's problem today however, is no longer one of fuel shortage but rather of plant shortage. The Minister of Fuel and Power has recently confirmed that Power Station coal is in

comparatively good supply and in view of the small demand made upon this type of fuel for export, restrictions upon the use of electricity can now be lifted provided that any additional consumption is confined to " off-peak " hours.

While the shortage of power station plant is being steadily overhauled, electricity consumption continues to increase and it may be two or three years before the gap between generating capacity and demand is closed. The fact remains that there is ample plant available to meet all demands outside the normal morning and evening " peak " periods. It is interesting to note that the estimated duration of the latter has been reduced during the coming winter, a pointer to the progress which has been made in plant construction.

Appliance Developments

The thermal efficiency of electrical appliances is already very high, and recent developments have been rather in the direction of improving their effectiveness. The design of electric water heaters has reached a high standard and, in order to take advantage of their good performance, the design and layout of electric water heater installations has been considerably improved particularly when electricity and solid fuel are used alternately for heating. Both sources of heating are thereby improved in efficiency.

Boiling plate design has also been improved, resulting in faster operation and higher efficiency and longer life. New methods of heat control have also resulted in further economies.

Industrial Smoke Abatement

The ubiquitous electric motor has now very largely replaced the small steam engine even where the exhaust steam has been of use for process heating. Steam driven cotton mills and colliery winding engines are in process of electrification whilst extensive suburban railway electrification forms the basis of recent long term planning proposals.

The large increase in electric vehicles is also playing its part in the reduction of atmospheric pollution in the streets of many large towns. Since the beginning of the war the number of " electrics " on British roads has more than doubled. There is an additional advantage here—the saving in dollar purchases of oil as the electric vehicle uses off-peak home-produced electricity.
—British Electrical Development Association.

Progress with Low Temperature Carbonization Fuel

The war and the conditions which have prevailed since the war have had a considerable effect on the development of processes concerned with the low temperature carbonization of coal. In the United Kingdom, the shortages of coal and structural materials have, of necessity, retarded the development and building of carbonization plants. At the same time the need for making the best use of such coal as is available and for the finding of substitutes for imported materials, has had a very marked influence on the development of processes for the treatment of the by-products.

This is most important, for it is not possible to buy coal, even small coal, do work on it, incur labour costs and, with a yield of 14 cwts. per ton, sell the residual smokeless fuel in competition with coal unless the best possible use is made of the by-products. The war period with its retarding effect on new construction has provided a desirable breathing space which has allowed the by-products section to gain the necessary lead.

Further development in Britain will, to a large extent, depend upon the implementation, by the Government, of the recommendations of the Simon

Report and the introduction of a satisfactory price structure for fuel as distinct from a coal price structure.

In Europe, apart from the United Kingdom, Germany was, prior to and during the war, the country in which the most progress was made in the industry. Germany has tremendous brown coal deposits and for war purposes the tar produced by the low temperature carbonization of brown coal became the principal raw material for the production of petrol by hydrogenation whilst the semi-coke so produced was used for the making of water-gas for the hydrogenation Plants.

The low temperature carbonization of bituminous coal in Germany was developed mainly between the two world wars. The Krupp-Lurgi Plant at Wanne-Eickel was built during 1938 and put to work in 1939. This Plant which, at its peak, had a capacity of 234,000 tons of coal per year, operated in conjunction with a Fischer-Tropsch Plant for the production of synthetic petrol and diesel oil until it was put out of commission in 1944 by Allied air attack.

A second Plant with a capacity of 90,000 tons of coal per year was erected at Velsen (Saar) in 1939. The object of this Plant was to provide smokeless fuel for domestic use, but it was not put into commission until 1942 as, with the outbreak of war, the inhabitants were evacuated. The plant was again shut down for a short period due to fighting in the area in 1945, but it was almost undamaged and still continues in production.

The most ambitious post-war scheme is at Pittsburgh, U.S.A. Here, as with other cities in America, it is unlawful to burn high volatile fuel in a way that will produce smoke, and the Pittsburgh Consolidation Coal Company who operate the "Disco" Process, are at present erecting a carbonizing plant to treat 380,000 tons of coal per year to meet the increasing demand for smokeless domestic fuel. Future development in America will no doubt depend largely upon the commercial success of this venture.—*Low Temperature Coal Distillers' Association of Gt. Britain.*

Central and District Heating

Progress during the past year has been disappointingly slow. Eleven schemes are actually under construction, and two more contracts are fixed or about to be placed, these including two New Towns, but actual development has been slow.

At Urmston 202 houses and at Salisbury 138 houses are now served and in occupation, and the tenants concerned appear to appreciate the service. Already it can be stated that these houses are obtaining heat and hot water, with a lower consumption of fuel, both in cost and quantity, than would be needed with traditional methods, although on both schemes at present only temporary boiler plant is installed, which will shortly be replaced with permanent plant of higher efficiency.

The point the Society is concerned with is Smoke Abatement, and it can be said of these schemes there is no need for it, they are practically smokeless already !

In all, 14 schemes have been approved and 6 other schemes are under consideration. 4 of those given in last year's list have dropped out, the schemes being abandoned, but several new schemes are under consideration. A list of those actually approved and the actual position (as in June) is appended. —*D. V. H. Smith.*

Schemes Approved and Under Construction

	Scheme	*Position*	*Consulting Engineers*
1.	Urmston ...	Commenced and 200 houses in operation	Donald Smith, Seymour & Rooley

	Scheme	*Position*	*Consulting Engineers*
2.	Salisbury ...	Commenced and 138 houses in operation	D.S.S. & R.
3.	Dagenham ...	Contracts now fixed and construction about to commence ...	D.S.S. & R.
4.	Paddington ...	Contracts now fixed and construction about to commence ...	D.S.S. & R.
5.	Swindon ...	Construction commenced ...	D.S.S. & R.
6.	Priesthill ...	Construction commenced ...	D.S.S. & R.
7.	Pimlico, Westminster...	Construction commenced ...	Kennedy & Donkin
8.	Bonnyrigg, Scotland	Construction commenced	Local Authorities No Consultant
9.	Brynmawe for Enfield Cables Ltd.	Construction commenced ...	J. Varming and ... C. S. Mardell (Arch.)

Schemes Approved

10.	Coventry ...		Kennedy & Donkin
11.	Wythenshawe ...		Ernest Griffiths

Schemes for New Towns

12.	Aycliffe ...	Scheme approved	Oscar Faber and Partners
13.	East Kilbride ...	92 houses commenced (1st 26 completed and operating) ...	D.S.S. & R.
14.	Woodside and Glenrothes	Scheme commenced for Woodside 376 houses and now extended to deal with first developments for the New Town of Glenrothes, as at present arranged scheme is to serve total of 800 to 900 houses	D.S.S. & R.

Smoke Control in Los Angeles County

Oral Contribution by Henry Burns of the Los Angeles County Smoke Control District, California.

The County is a territory of 46,000 square miles, which includes 45 incorporated cities of various sizes, the largest of which is the city of Los Angeles, which to-day has a population of not quite two million. The County is in the form of a peninsula, bounded on the south and the west by the Pacific Ocean, and on the north by a semi-circular range of mountains averaging 5,000 ft. in height. About 30 to 50 miles from the west coast there is a perpetual high pressure area. Over the entire land-board are "planes" of temperature inversion, varying in height from ground level to approxi-

mately 3,000 ft., and recorded observations have shown that the temperature at the base of the inversion have exceeded by over 14 deg. F. those on the ground. Thus, with the prevailing off-shore breezes and the back-drop of ground, sources of atmospheric pollution must necessarily spread laterally. Back in 1940, before the war, the area included approximately 1½ million people, and there was little industry—somewhere in the neighbourhood of 2,000 industrial factories. To-day the area includes not quite four million people and over 10,000 industrial plants. Because of the tremendous increase in industry and the influx of population, the pollution has increased by leaps and bounds, and public opinion has forced the issue and demanded air pollution control.

In the early 1940's the city of Los Angeles saw fit to enact an Ordinance about air pollution, which in the main was related to smoke. Very shortly afterwards the County saw fit to enact a similar Ordinance. However, these two Laws paralelled each other, and the jurisdiction of each was restricted to their respective areas (as far as the city of Los Angeles was concerned, to uncorporated areas of the County). The County, realizing the necessity for an overall control, then relegated me, in conjunction with the County Council, to approach the governments of the remaining 44 cities to ask them to enact an Air Pollution Control Ordinance similar to that of the County, and to enact additional legislation to empower the County to enforce it.

After travelling about with the County Council for eight months we succeeded in getting 25 of 44 remaining cities to enact legislation. As the result of being one of the newest States who were interested in this particular work, we decided to look into the problem of air pollution control. Industry fought it tooth and nail, but we succeeded in getting legislation through as a section of the State Health and Safety Code to give a basic Smoke Law, empowering any County within the State to invoke the sections of the Act within the limits of that County. These Counties could also in their legislation impose any rules or regulations, but they had to be more stringent.

The position became violent, but we succeeded; Los Angeles was the only County to push the legislation through. The organization within the district consists of approximately sixty people. All are engineers or engineers in training, smoke inspectors, etc. All these people are seriously engaged in this work. We have quite a number of dollars to play with! The annual budget is somewhere between £100,000 and £150,000. Motor cars are provided to travel to destinations; laboratory and research facilities are incidental, but the moneys involved are considerable. The method of smoke control in the County is that we follow the basic Smoke Law, but it probably will be a great surprise to you that we work on the basis of the Ringelmann Chart. We state that a person shall not discharge into the atmosphere any air contamination for a period of more than 3 minutes in any one hour as dark or darker in shade as shown as No. 2 in the Ringelmann Chart. In addition, we have the following: a person shall not discharge from any source such quantities of air pollution as to cause injuries, detriment, annoyance or a nuisance to any considerable number of persons, or which endanger the comfort, repose, health or safety of such persons. In addition, a person shall not discharge into the atmosphere particular matter in excess of 0.4 gr. per cubic ft.

Specific contaminants: A person is forbidden to discharge sulphur compounds in excess of 0.2 per cent., or solid products of combustion calculated at 12 per cent. of CO_2.

We have also established a table in relation to the emission of dust and fumes, and have tried to take into consideration the problem of the small manufacturer as opposed to the large industrial concerns.

We have prepared a method of control whereby our Smoke Inspector is appointed as Deputy Sheriff, with the police power thereto attached. He has the right to issue a citation to the individual offending the public, or,

failing the latter, ordering him immediately to cease. Failure to comply can result in fines varying from £100 for each and every offence. Jail sentences may also be given. We do not propose always to invoke this legal matter, but we also have the right to shut down any plant that does not comply with the Law until such time as it does. This brings very excellent results.

The problem of Prior Approval; you people are toying with it—we have it. Under our rules and regulations no person or Company can install any piece of equipment which is capable of producing air contamination unless it has first received prior approval from us. We can, if necessary, go to the extreme of shutting down the plant and stopping work, or arresting the individual.

In the area of California in general we burn no coal of any kind. Fuels are natural gas, oil and hydro-electric power. We have a great number of major oil refineries. These refineries emit approximately 1,200 tons of sulphur gases per day. This causes us some trouble, but with the equipment we have made these people install they can now collect about 300 of this 1,200 tons. Additional plant will be installed which will collect 500 tons, and in two years the remainder will be collected.

However, we have felt that in the organization we have set up to-day in the method of application of the law, we have propounded and put into use a model Ordinance. We have praise from every part of the world, and we recommend our method as it has worked out.

In the eastern area of the country they have finally reached the conclusion that the homes as well as the industrial concerns must install some kind of mechanical stoker, where they burn soft coal. This is something more difficult to enforce.

I should like to add that there are two men appointed to patrol the highway to watch emission from road vehicles; another man goes to the railroads to watch for engine smoke, and another man watches ships in harbour for the same purpose. When an offending vehicle has been stopped on the highway and has been cited twice within a 30-day period, he comes before the Board.

Discussion on Progress Reports

Mr. Arnold Marsh (General Secretary, N.S.A.S.), opening the discussion by reviewing the reports, said that the most important matter they revealed was the progress—or absence of progress—towards the new forms of legislation that were required for the more effective prevention of atmospheric pollution. He asked the conference to consider carefully the statement on behalf of the Society included in the reports, and to compare it with the reports from local authorities using Prior Approval procedure. It would be seen that the complexities and difficulties involved in securing new legislation were formidable, and must be thoroughly discussed.

One or two matters stood out in the reports. First, it was now clear that Prior Approval, if it were to be successful, must be obligatory. Secondly, that any approach through the medium of byelaws seemed to create a host of new difficulties of its own. The conference should note the experiences of the City of London in Dr. White's report. It was clear that so long as the Ministry of Health required byelaws to include a detailed list of specific requirements to be followed in installing new fuel-burning plant, it would be impracticable to press for and operate Prior Approval by such means. The problems that such procedure would create could be contrasted with the

relative simplicity of what is being done to-day in the United States and elsewhere. The contribution by Mr. Henry Burns to the discussion was a first-hand testimony of how Prior Approval could be made to work.

It must be remembered that smoke abatement legislation in this country was at least 75 years out of date—it was very little different from that contained in the Public Health Act, 1875, and could properly be described as stable-door legislation. Action could be taken only after smoke had been emitted, whereas the objective should be to prevent conditions that might result in smoke emission.

The reference to the opposition of business interests to the Birmingham Bill would have been noted. There had been a similar failure to discuss new legislation with the Society, and revealed an attitude that the smoke abatement movement must regret. Again, comparison could be made between this and the much more enlightened outlook shown by industry in many of the American cities where far more drastic legislation was actually in force—the article in the current (Autumn, 1949) issue of *Smokeless Air* on the new smoke law in Allegheny County, Pennsylvania, well illustrated that.

The reports from Manchester and Salford on Smokeless Zones would also have been noted with interest: here again was an important development feeling its way forward in the face of difficulties, especially those arising from the prevailing fuel supply situation. Action taken by Rochdale should not be overlooked, although in that case there was nothing to be added to the activities that were reported in *Smokeless Air* for

A further matter of importance to be noted in the reports were the excellent examples of co-operation among groups of local authorities for action in respect of specific problems—namely, in those from the Thames-side area and the Carrington district. It was interesting to see that plans were being made for an investigation into the effects of atmospheric pollution on plant life in the latter case. This, it could be hoped, would in due course produce some new data of value for strengthening the case against smoke.

Except perhaps on the subject of district heating, the reports on the smokeless fuels and systems were not likely to cause much questioning, though they were welcomed in showing how the means for promoting smokelessness were making progress. Finally, although the reports gave an indication of the wide variety of matters with which the Society was concerned, they did not reflect the growing concern of the public about the problem—a concern reflected in the increasing number of inquiries, complaints, and requests made to the Society.

James Law (Chief Smoke Inspector, Sheffield) said that he was going to be particularly pessimistic, for during his thirty years on smoke abatement work, he had never seen such a dismal picture presented in print.

The Society had in his opinion made a serious mistake in the naming of the Report. It should have been called "A Report on Frustration." On page 15, under the heading "Towards New Legislation," it was stated that "at the *end* of *1947* the Society published the tentative proposals for new legislation." This approval took place at Brighton in *1946*, so for some obscure reason the Society has lost a year's work!

Mr. Law commented on sections in this report as follows:

(*d*) The Public Health Act, 1936, gave powers to local authorities to make byelaws respecting new buildings and these byelaws *should be compulsory*, if they were applied.

(*e*) Where there was a Planning Committee operating, it was obligatory for any plans of new premises to be submitted and approved by them, so that when such plans are submitted, in liaison with the local authority concerned, they could be considered and approved, or amended. Appeals against Planning Committee rulings were now heard by Inspectors appointed by the Ministry of Town and Country Planning: but in the case of the Public Health Act, it was thought that appeals would be heard by the Ministry of

Health Inspector, in the same manner.

(*f*) It was his opinion and probably that of every delegate to the Conference, that *Town Planning* and *Smoke Abatement* should work simultaneously and become part of a general scheme. Planning was going to be of little use in a polluted atmosphere.

In Sheffield they had been working on those lines with a modicum of success; some of the recent difficulties would be emphasised later.

(*g*) The problem of the sale and use of bituminous coal was an issue that should not be included, or added to this subject, at present.

(*h*) The plans of the Government Departments and nationalized industries could apply, just as they did at present. Courtesy plans were submitted for approval and suggestions were submitted, with regard to the types of fuel and the appliances to be used.

The Registration of Firemen was a question that *could not be divorced* from the problem of Prior Approval. It was of little use insisting on suitable fuel and appliances, if a competent person was not operating such appliances. An essential part of the scheme was the *certification of all operators*. It was stated that Prior Approval could not have been thought of ten years ago, but he would remind them that such a scheme was outlined in a symposium on "The Rebuilding of Britain" in the Spring issue of *Smokeless Air* in 1941, by the present speaker.

This proposed legislation has been submitted to various organizations throughout the country. Many and varied had been the amendments suggested, with the result that there was a confusion of ideas with regard to the whole matter. Had these proposals been submitted to the Ministry of Health in the first place, something tangible might have resulted before now.

In the meantime, many local authorities who were anxious to put their reconstruction into operation, asked for similar clauses to be included in their Corporation Acts and had had them inserted with little or no uniformity of action. Many added provisos making them almost unworkable.

They would have read the sorrowful tale on pages five, six, seven and eight where very few plans have been submitted under the Local Acts and at Birmingham and London, plans for "Prior Approval" had not been granted.

National Fuel Policy.—Last year at Cheltenham they were pleased to have Mr. Gaitskell, the Minister of Fuel and Power addressing them. In his speech he made reference to a National Fuel Policy. He stated that people should be free to have individual preferences in this matter "and to choose coal, gas or electricity according to their desires." How did this work out in practice? In Sheffield, they had been working "Prior Approval" of all fuel burning appliances for over 2½ years and during that time over 1,200 plans had been examined and approved. The declaration of a National Fuel Policy would have been an excellent guide with regard to available fuels, but decisions had to be agreed upon locally, having regard to the fuel supplies that were available.

In the Central and Residential Areas, gas and electricity only were asked for because smokeless fuels were at least £1 per ton dearer than bituminous coal. For light industry oil, mechanical stoking and coke burning were agreed upon. In the heavy industrial area, the best terms for mechanical stoking and suitable appliances was all that could be expected but a minimum chimney height of forty feet was asked for.

This scheme worked admirably until recently, when the Ministry of Fuel and Power issued instructions that gas and electricity for space heating would no longer be allowed, though they did not state there was *any particular shortage*. When pressed for a reason it was stated that all available gas and electricity must go to industry for export production and that the gas undertaking was becoming embarrassed by their commitments. If he told them that for many years, millions of cubic feet of gas from the coke-ovens had been *and were being sent* to atmo-

sphere every week-end, this action was one that required some explanation.

The total amount of gas asked for in the Central Area to date has amounted to about one-tenth of one per cent. of the daily consumption figure, but this had been refused. How could Town Planning and Reconstruction be carried out on rational lines when the Ministry most concerned would not co-operate in the matter?

Electricity Power Stations.—On page 25 was a brief report on progress with electricity with a special paragraph dealing with power station progress. All that could be said in this matter was that the people who had the misfortune to reside in the vicinity of these power stations were more long-suffering than most, for the amount of dust and sulphur laden vapours emitted daily increased with the added output and "*higher efficiency*" of the plant. At present, these power stations were working with an utter disregard for the amenity of any district or the comfort of adjacent residents.

Could not the Conference be asked to demand from the Government a suitable National Fuel Policy and from the British Electricity Authority the right of every citizen to live in comfort whether in the vicinity of a power station or otherwise?

G. W. Farquharson (Midlands Joint Advisory Council for the Abatement of Smoke and Atmospheric Pollution) said he was sure they were all indebted for the information and the views expressed by the various authors in the series of progress reports, and although they were comparatively new in their Conference proceedings, he felt they raised some interesting points for discussion.

In the contribution "Towards New Legislation," the General Secretary had tabled a series of questions, mainly, he took it, to get guidance in future policy in regard to new legislation. Some of the progress reports gave answers to those questions. For example, under the contribution "City of London: Byelaws for Prior Approval," it would appear that the Ministry of Health would be prepared to consider and confirm byelaws which were not open to criticism, but that those byelaws when submitted should be specific. Assuming this view was correct, then it would appear that the proposed new legislation, which, it would be remembered, was discussed at the Brighton Conference three years ago, would have to be re-drafted in more specific terms.

It was the question marked (f) on page 15, "To what extent can the powers conferred by the Town and Country Planning Act, 1947, Section 14(1) be used by Local Authorities to prevent smoke?" that he found most interesting. That Act became operative in July, 1948, and consolidated the previous Acts, and experience in his local authority had convinced him that a great deal of constructive work could be done under that Act when there was complete liaison between the technical staff of the Public Health Departments and the Town Planning Authority. Roughly speaking, Section 14(1) of the Town and Country Planning Act, 1947, stated that when application was made to the Local Planning Authority for permission to develop land, the Authority might grant permission, either unconditionally or subject to such conditions as they thought fit, or they might refuse permission, and in dealing with these applications the Local Planning Authority should have regard to the provisions of the development plan so far as material thereto, and to any other material considerations.

Assuming the Town Planning Authority considered the question of smoke abatement was such that it deserved a place in their planning, then the last paragraph "and to any other material considerations" could be applied. It therefore followed that any Town Planning Authority, if they were so minded, or should he say smoke conscious, could impose conditions to secure as far as possible that the fuel burning plant which was to be installed in any building should be comparatively smokeless.

This was of far reaching importance and Mr. Farquharson assured his listeners that the experience in his

Local Authority under this Section had been very valuable. The liaison between the City Surveyor's Town Planning staff and the Public Health Department had been strengthened and, at this juncture, he would fail if he did not recognize the help given by the City Councillors who served on the Town Planning Committee. It should be remembered that they had the final word and it was their goodwill, interest, and support, in matters towards ensuring smokeless conditions that was greatly appreciated.

There was also the Use Classes Order, 1948, made under the Town and Country Planning Act, 1947. This Order defined the different classes of industry and trade processes into a number of Groups applicable to the zoning requirements. For example, Light Industrial buildings were defined in the Order as industrial buildings in which processes carried on or the machinery installed were such as could be carried on or installed in any residential area without detriment to the amenity of that area by reason of fumes, smoke, soot, ash, dust and grit, etc.

It therefore followed that any Planning Authority, with the experience of the technical officers of the Public Health Department, could get valuable advice on the suitability as to whether an application for a certain trade process could be classified as a light industry, and again the Planning Authority could impose certain conditions to ensure that atmospheric pollution would not be created.

He knew it was said that this liaison can only be worked in a large industrial city where planning control and the Public Health Department were in the same Local Authority, and that difficulties occurred where the planning Authority was more remote. He did not think these so-called difficulties need exist, and it should be remembered that the Local Planning Authority could, if they so desired, and with the consent of the Minister, delegate any of their powers under Part 3 of the Act, which dealt with control and development, to the various Local Authorities.

G. H. Wilkinson (Corby U.D.C.) said his Council would regret there was no mention of the Iron and Steel Industry, and no specific reference to the exemption clause in the Public Health Act.

Reference had been made to the increased use of gas in the Sheffield area, but one was apt to forget that in many cases, as at Corby, this gas was produced by the industry itself, in coke ovens. These ovens were a prolific source of smoke, every hour of every day of the year.

Any new legislation which perpetuated the exemption clause should include a review clause. A similar clause in the old 1926 Act (omitted from the 1936 Act) had so stimulated the industry in Sheffield that extensive research was undertaken, one of the main results being the substitution of gas for coal.

W. B. Kennedy (Senior Smoke Inspector, Manchester) pointed out that he was not a delegate from Manchester, and was not entitled in the slightest degree to speak with any official status on smoke abatement. As a private member he was disappointed with the reports, and he hoped he was not attending a meeting of a Mutual Admiration Society.

He had listened with great interest to the go-ahead methods in Los Angeles and reflected that 50 years or so ago we were well ahead of America in many aspects of environmental hygiene. Admittedly, our smoke abatement legislation now seemed to be well behind, but we could not plead that out of date legislation was the sole cause of our atmospheric pollution problems. The indifference of our local authorities was the principal cause. As an example, over half the Local Authorities did not trouble to reply to a recent questionnaire from the Society. From all the Local Authorities in Britain, the National Smoke Abatement Society only received about £2,000 a year to carry on its work. In his opinion over 90 per cent. of the Local Authorities took no statutory action to enforce the law dealing with smoke abatement.

The City of London report admitted

Illustrations to "The Problem of Burning Spoilbanks" by J. Carr (Page 46)

Fig. 1
Emission of sulphurous fumes from crater

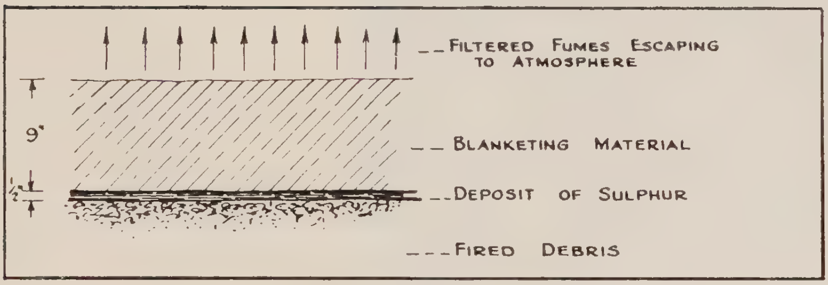


Fig. 2
Illustrating effect of blanketing

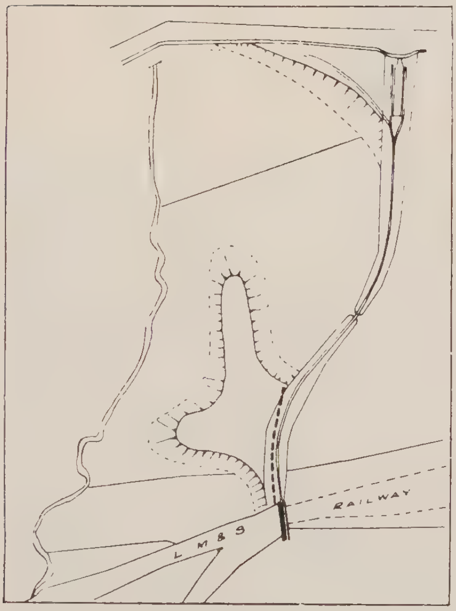


Fig. 3
Plan showing proximity of fire to railway

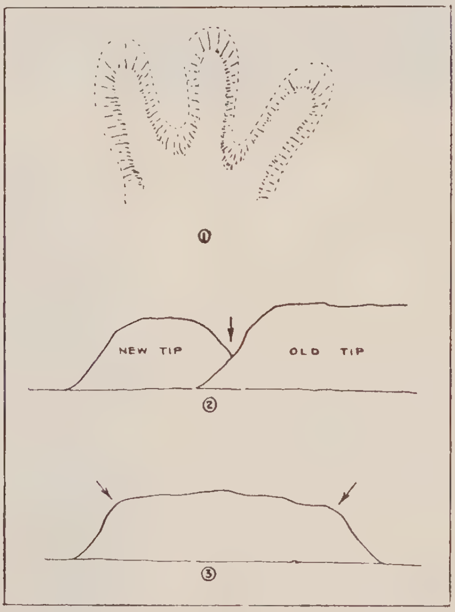


Fig. 6
Mistakes in tip formation

Fig. 4
Lime barrier trench

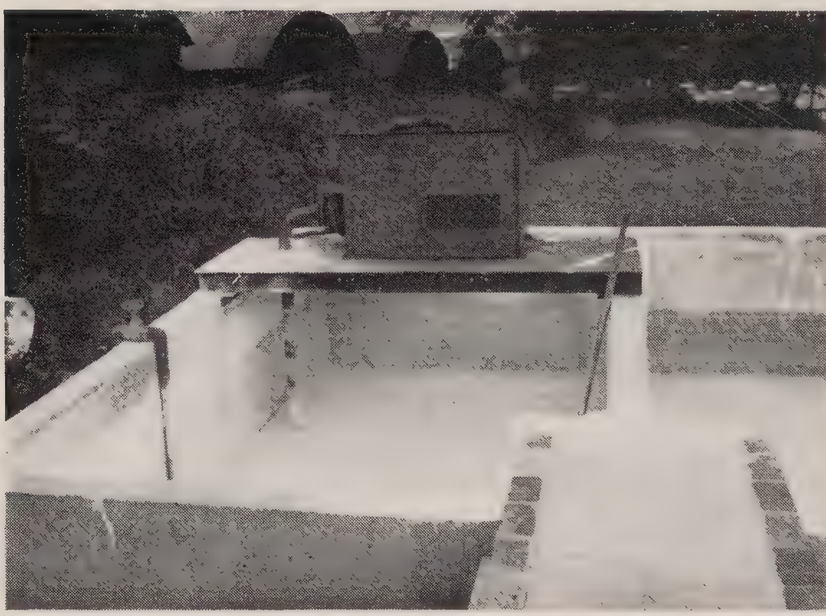


Fig. 5
Lime mixing tank

Fig. 7
Liming as tipping ground advances

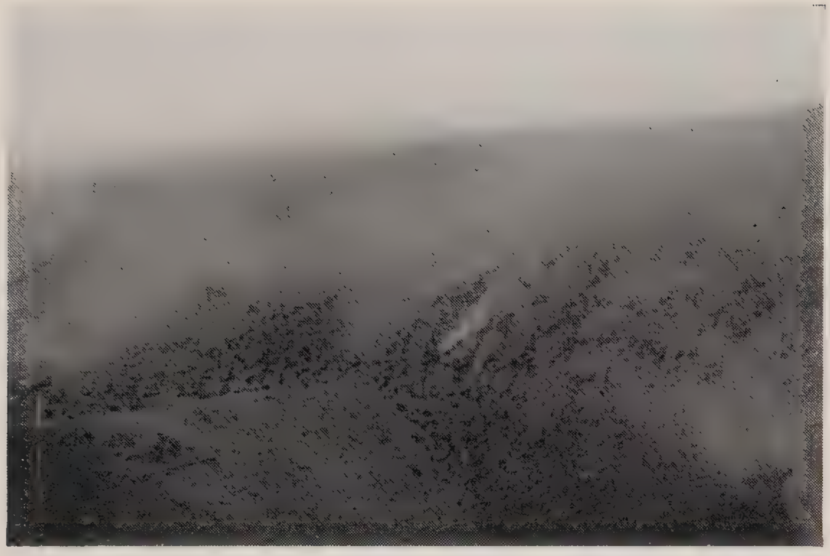


Fig. 8
Spoil heap before treatment

Fig. 9
Spoil heap after treatment

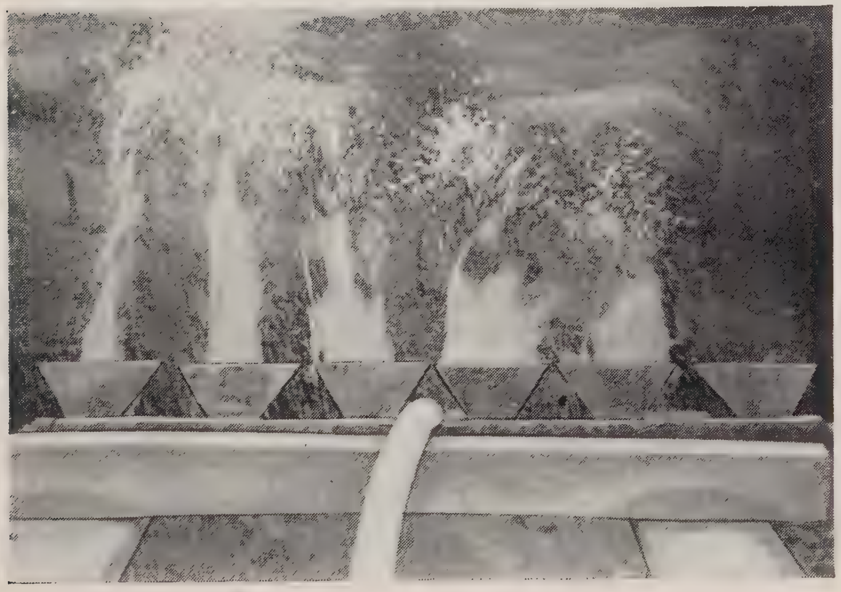


Fig. 10

Special type spray

Fig. 11
Lime effluent sump and pump

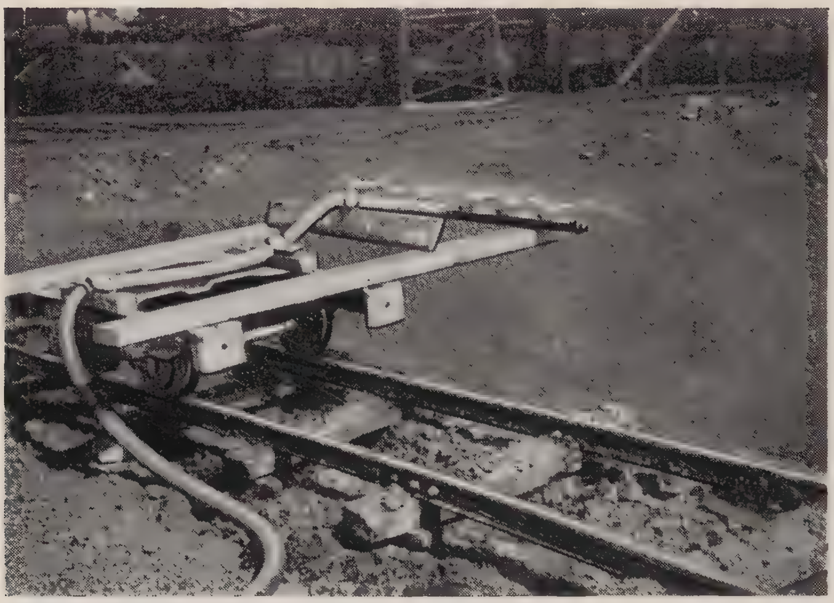
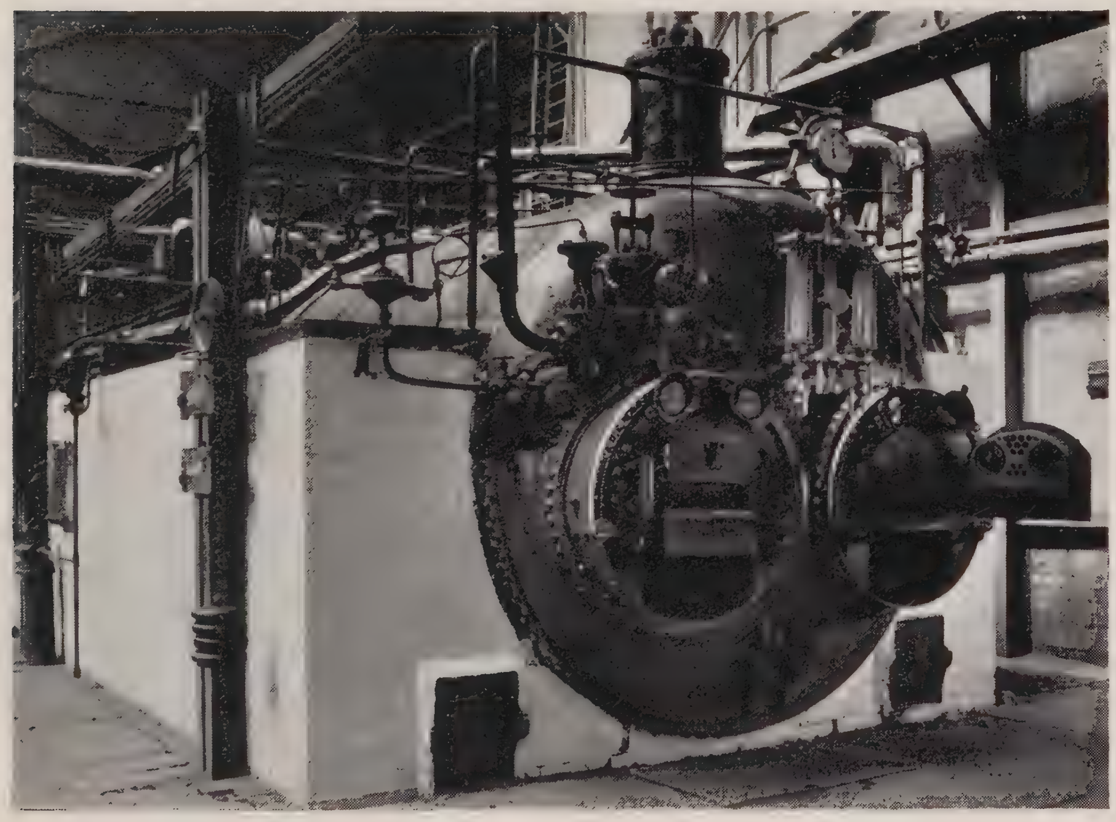


Fig. 12
Bogey carrying sprays

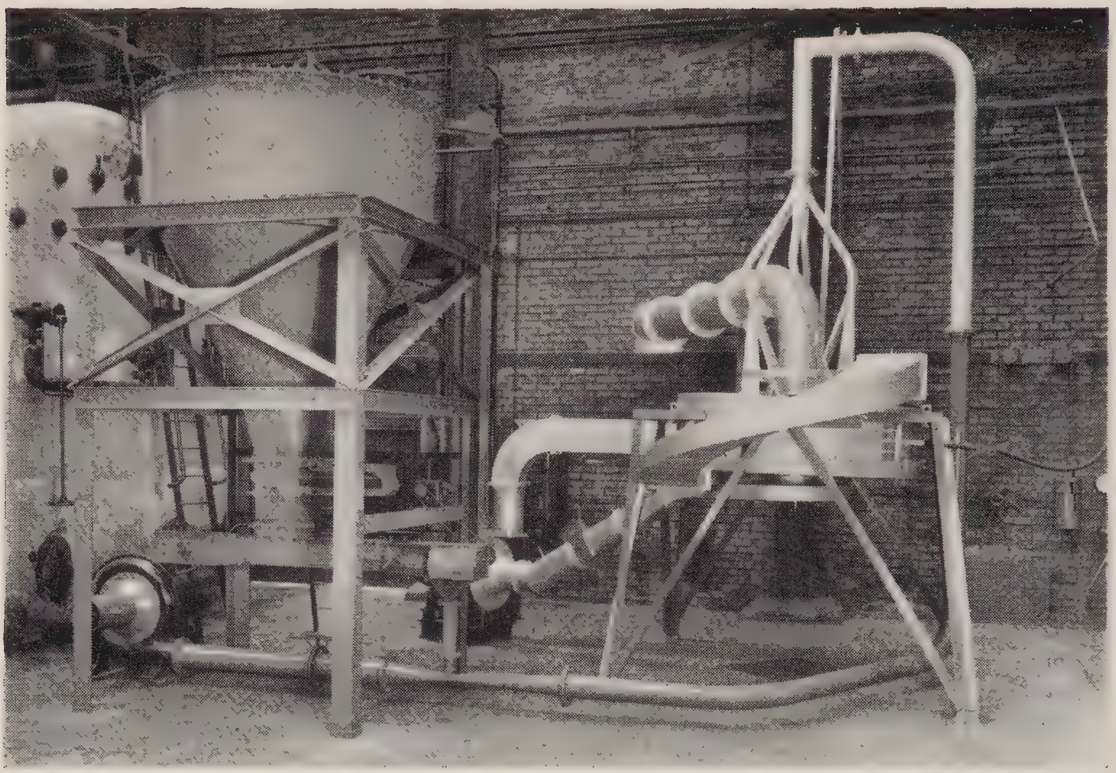
Fig. 13
New tip over old

Illustrations to " The Work of the Fuel Research Station " by Dr. A. Parker (Page 56)

The Fuel Research Station



A Lancashire boiler fitted with Fuel Research smoke eliminator doors



A vortex combustion chamber designed and built by the Fuel Research Station

A small scale plant for experiments on the synthesis of hydrocarbons by the Fischer-Tropsch process

A lead peroxide instrument for measuring pollution by sulphur dioxide on the roof of St. Paul's Cathedral

The testing of modern cookers for multi-purpose duties—baking, hot-plate cooking and water-heating

The control room in the calorimeter building erected at the Fuel Research Station for research on methods of testing domestic heating appliances

A trial shot with the special flamethrower fuel developed at the Fuel Research Station

Experimental plant developed by the Research Station for orchard heating to prevent frost damage to fruit crops

that many Local Authorities might not have on their staffs officers competent to adjudicate on plans, sections and written particulars of proposed installations and suggested that the Ministry of Fuel should approve or disapprove of new industrial installations so far as smoke abatement was concerned. Under such circumstances he wondered with what degree of enthusiasm the existing law was being carried out by some of these authorities.

It seems rather amazing that they are willing to hand over local control to a central authority instead of getting on with the job themselves. Did not many think that they were getting too much centralization, and that there were advantages in control by Local Authorities?

There was great scope for discussion in the other reports. He would like to draw attention to one item. In his experience, the principal cause of industrial smoke nuisance was unskilled firing. A most efficient plant complying with every requirement could cause continual nuisance by unskilled attention. The primary and most elementary step to secure industrial smoke abatement was the registration of all firemen. Certification could follow later.

H. Moore (North-West Divisional Council N.S.A.S.) congratulated the authorities who had contributed progress reports, but deplored the appalling lack of interest which still seemed to exist, particularly among local authorities. He pointed out that in their replies to the National Survey questionnaire, towns with populations ranging as high as 80,000 made no reference whatever to the domestic smoke nuisance.

He compared the progress made in this country with that made in America as related by Mr. Burns, and suggested that every member should have a copy of Mr. Burns's address.

Contrasting the spate of official directives with regard to housing and food with the few received on atmospheric pollution, he stated that the Government should be foremost in the smoke abatement campaign. The milk allowance was about half a pint a day per head and considerable effort was made to ensure that it was wholesome and pure. On the other hand, each individual consumed 3,000 gallons of air a day and few seemed to care how much it was contaminated. He favoured the acquisition of further legislation to control smoke, but pleaded that local authorities should exercise their existing powers. He considered that the Society should resist any attempts to exclude plant belonging to the Government or nationalized industries from control in the matter of industrial smoke.

He recommended all delegates to develop a sense of urgency in the smoke abatement campaign and stated that no reform would confer greater universal benefit upon humanity.

H. Hetherington (Individual Member) said there seemed to be a reluctance to enforce training for boiler house operatives. Prior approval of plants he fully agreed with, but it should be coupled with prior approval of boiler firemen. It was bad practice to put in approved plants without fully trained operators.

C. A. Stansbury (Walsall) after paying tribute to the most valuable contribution of Mr. Burn said that he was disappointed with the progress report on electricity. Acknowledging the valuable contribution which electricity had made to the abatement of atmospheric pollution generally, it was disappointing to find no reference in the report to any action being taken by the British Electricity Authority to control atmospheric pollution whether by smoke, grit, dust or sulphur fumes from the giant new stations or existing electricity undertakings where nuisances had or could affect persons living in the neighbourhood of these stations.

Mr. Stansbury also asked Mr. D. V. H. Smith who had reported on central and district heating, whether he could give the actual cost per week in rent with regard to the schemes already in operation, and whether there was any prospect of new schemes being allowed to develop in view of the present economic situation.

Dr. C. F. White (City of London) said it appeared to him that the Ministry of Health were afraid to give local authorities "prior approval" powers at a time when the supply of suitable fuels was difficult and maximum output from industry was essential by reason of the economic crisis. Moreover, the Ministry appeared to want "prior approval" byelaws to be absolutely detailed and specific in regard to what would be required in fuel-burning appliances. He felt that it was neither practicable nor desirable for byelaws regulating fuel-burning appliances to be so detailed as were building byelaws and drainage byelaws. He was not a technician, but it seemed to him that the appreciation of plans, sections and specifications of a large fuel-burning installation must need a very high degree of technical skill. While certain large industrial towns could have such highly qualified officers on the local authority's staff, smaller towns could not; yet they might have some large industrial concerns in their area. He favoured local authority control rather than Central Government control, wherever practicable, and that was why he had suggested that the Ministry of Fuel and Power should have combustion engineers on their Regional Staffs to whom Local Authorities could submit plans and specifications of large fuel-burning installations, for criticism. Local Authorities would nevertheless be responsible for granting approvals and for supervising operation and maintenance. His suggestion was not intended to be in any way derogatory of smoke inspectors.

G. A. Vowles (Divisional Controller, British Electricity Authority, Yorkshire Division) replying to the criticism by Mr. Law, wished to inform the Assembly that contrary to Mr. Law's accusation that power stations were working with utter disregard for the comfort of other people, it was necessary to point out in reply that the British Electricity Authority were very fully aware of their responsibilities in preserving, not only the amenities of a town or district, but also the health and welfare of our citizens, and he informed the Conference that the British Electricity Authority were spending something like 5 per cent. of the total capital expenditure on new power stations to take care of grit and smoke emission. Bearing in mind also that the Authority contemplated something like £400,000,000 on new plant over the next few years, it could be appreciated by the Conference the extent to which the British Electricity Authority were prepared to go.

Mr. Vowles also drew the attention of the Conference to the fact that the expenditure contemplated by the Central Authority was largely necessitated by the poor contribution towards the desired objective by owners of electricity supply undertakings many years prior to Vesting Day, many of which it should be remembered were Municipal Authorities.

Donald V. H. Smith replied to questions asked in the discussion, as follows:

(1) What chances were there of any large scale District Heating?

Reply—At present two new towns and two existing ones were seriously considering large scale district heating. He thought at least two of these looked promising, but it was a little too early to say as no final decision had been made.

(2) What were the present weekly charges?

Reply—The existing charges per week to housing varied from 3s. 9d. to 7s. 3d. per week, but it should be borne in mind that, except for Dundee where two schemes had been working for over twenty years, the only two others working at present had merely the first small portions recently started up and were still incomplete. The present costs on these last two schemes were considerably above the charges mentioned earlier, but development costs in the early stages on any scheme would naturally be high on the first few houses. One could not expect the gas or electricity works to be started to serve 50 or 150 houses and pay its way. At present, the two schemes under consideration had only about 150 houses each in operation. When

completed he was still of the opinion that the economy charge necessary will vary between 6s. and 8s.

One factor must be borne in mind when militating against economy in the early years, that was slow development. To operate 100 houses, the labour of two men, and a relief, was required; the same labour could easily operate 800 houses, or even 800 houses and several other buildings. In the first case the cost would come out at about £8 per house per year; in the second case the cost would drop to £1 per house per year. With other buildings attached to bear the cost of labour the charge for labour on housing might even be nil.

(3) Was there any immediate future for district heating?

Reply—Yes, apart from the two additional schemes above mentioned, there are another eight or nine schemes actually commenced, but in giving this answer he would advise enquirers to beware of planning developments of scattered estates with semi-detached houses about 8 or 10 to the acre. Properly developed neighbourhood units planning for a number of terraces, flats and other buildings should enable a very economical scheme to be produced, and the future of district heating depended upon due regard for this aspect of planning.

THE PROBLEM OF BURNING COLLIERY SPOIL-BANKS

BY

J. CARR, M. Inst. F.

Chief Scientist, No. 7 Area, East Midland Division, National Coal Board.

Introduction

The problem of burning spoil-banks is one which has exercised the minds of colliery management for a long time.

During the war years, when the flames from burning spoil became a menace to areas in which they were situated, efforts were made to keep down such occurrences and a close and continuous watch had to be kept upon burning spoil.

The measures which were then adopted took the form of applying jets of water to the seat of the fire, either in the form of open-ended hydrants, or through specially constructed sprays, the object of the latter being to spread a blanket of water over as big an area as possible.

By these methods the object of keeping down surface flames was accomplished but they were by no means a cure for the greater problem of reducing the fire in the spoil itself. Rather was it found that the focus of heat was merely transferred from one point to another, and the area of heating extended. This meant that in the course of time more sprays and more water were required to meet such extensions.

In the list of Burning Spoil-Banks it is stated that certain fires have been brought under control by *continuous* spraying. The secret there lies in the term *continuous spraying*. This presupposes that an almost unlimited quantity of water is available to saturate and keep saturated the material of which the bank is composed. The area in which the work described in this paper was carried out is not blessed with a plentiful supply of water, so that other methods had to be adopted to eliminate as far as possible the use of water.

This Paper is a brief account of the work which the Board are doing in South Derbyshire and Leicestershire to reduce the nuisance of burning heaps. It may be that this work is only applicable to this Area due to an abundant supply of cheap lime waste and limestone grit being readily available.

The problem of very large tips such as those put down by aerial ropeway is outside my present experience but the Board is alive to the general problem and, although results may not be as speedy as one might desire, the problem is receiving attention.

Methods adopted in South Derbyshire and Leicestershire

Two methods were found to be successful, which may briefly be described as (a) blanketing and (b) trenching. They were designed :—

(1) To reduce the nuisance of the sulphurous fumes escaping to atmosphere.
(2) To eliminate surface flames.
(3) To isolate a fire which endangers property or is likely to interfere with the running of the mine.

The following are examples of how these problems have been successfully dealt with :—

(a) *Reducing sulphurous fumes and surface flames.*—A fire had started spontaneously in a tip, where the material consisted of a concentration of a mixture of a highly pyritic nature. Water was being applied to keep down surface

flames. The fire spread, and complaints were received that the sulphurous fumes escaping were drifting into the village and creating a nuisance.

A coating of limestone-dust was thrown over the tip and filtration of the fumes immediately began to take place with a corresponding reduction in the objectionable sulphurous smell which had been carried into the village.

*Fig.1 is interesting in that it shows the cause of the problem from the nuisance angle. This is a typical example of the condition prevailing on the heap which has fired. It shows a small crater encrusted on its edges with a sulphurous deposit. The sulphurous fumes can be seen passing to atmosphere. All such craters were filled and covered over with limestone. The effect of the coating of limestone is shown diagrammatically in Fig. 2. The thick deposit adhering to the underside of the blanketing material commonly occurs when this method of treatment is adopted.

(b) *Isolating a fire endangering property.*—Alongside this spoil-heap runs a single-track railway line (Fig. 3), which is a most important coupling road between the screens and a boat dock, and also leads to the present new tipping ground. It was essential that this line should be maintained. The bridge carrying this line passes over the main line, bringing in empties and taking out coal from the colliery.

The fire had spread down the side of the line to within 1 yard of the bridge and was actually steaming from the edge of the sleepers carrying the line.

A trench was excavated from the bridge along the side of the line to a point on the bank where the fire originated (Fig. 4). Into this trench was pumped the effluent from the colliery water softening plant. The waste from the softener was collected in the concrete tanks, water added (which was pumped up from the brook), and the mixture sent down to the trench by means of the pump mounted on the top (Fig. 5).

* *See Figs. on page 35*

After some time it was noticed that the water seeping away from the bottom of the bank was crystal clear, indicating that deposition of the lime particles was taking place. The fire began to recede from the bridge and track and has now almost completely gone from that portion of the bank.

(c) *Problems arising when making new tips.*—Experience in South Derbyshire and Leicestershire suggests that there are three possible danger points to be taken into account when considering a new dirt-disposal scheme :—

(i) That tips constructed in the form of fingers leave a large surface area exposed to the air, and are, in consequence, more liable to spontaneous heating (Fig. 6).

(ii) Tips built near to existing old heaps are liable to fire if allowed to have a point of contact between the new and the old.

(iii) Tips constructed to give a single face of advance but with one or more corners exposed are liable to give trouble. These corners are suspect from the point of view of spontaneous heating.

The third set of conditions occurs at one of the collieries in the Derbyshire Area and a coating of limestone is applied as a precautionary measure against heating, and this is carried forward at regular intervals as the tipping ground advances (Fig. 7).

A further precautionary measure is taken by separating the nodules of pyrites, and these are tipped into a disused part of the canal. This is not a practical procedure everywhere when tips are on fire.

Work at another colliery, where a major fire is burning throughout the whole tip and which it is considered impossible to put out demonstrates a further approach to the successful control of fires where the fired ground must continue to be the present and future tipping ground.

Fig. 8 shows the appearance of this tip before remedial operations were

commenced, and Fig. 9 the same tipping face after treatment.

This improvement was brought about by making a zone of an admixture of lime with the material tipped between the face already burning and the new tipping face. At the end of a shift's tipping, the material on the face of the bank was covered with a film of lime effluent, placed there by means of specially-designed sprays (Fig. 10).

This was followed by further tipping, at the end of which a further application of lime was given. This treatment over a period of time established the desired insulating zone. When the tip reaches the extent of the boundary available for tipping a blanket of waste lime or limestone grit is applied as a finishing treatment.

In order to facilitate the foregoing treatment a sump was constructed and a suitable pump installed to convey the lime effluent to the scene of operations (Fig. 11). At suitable distances the pipeline was tapped for coupling to the sprays, which are run along the edge of the tipping face on bogeys (Fig. 12).

Because this colliery has covered the whole of its available tipping area, which was very limited, and has already served for many years, it now becomes necessary to continue tipping on the old bank at a higher horizon. (Fig. 13). The surface of the old burning heap has, therefore, been coated with lime waste, which not only is acting as a filter for fumes but which it is believed will also give a safety zone of inert material between the old and new tip. This, with continued treatment, will go a long way towards alleviating what has been for so long a most troublesome spoil-heap fire.

Summary

The paper briefly describes with examples what is being done in the South Derbyshire and Leicestershire coalfield to overcome the nuisance of burning spoil-banks. There is no abundance of water in this area and so the continuous spraying and saturating of the spoil-banks with water is impossible. In any case this method of treatment frequently results only in shifting the seat of the fire. The methods described are variations on the theme of blanketing the spoil-bank with lime waste from colliery water softening plant and with limestone dust. These materials not only form consolidated zones preventing the access of air to the fire but also act as a filtering medium for the sulphurous fumes.

Acknowledgments

This paper is published by permission of the National Coal Board, but it relates to the personal experience and views of the author, and should not be taken as necessarily committing the Board.

The original work was carried out before Nationalization when the author was Chief Chemist to the Moira Coal Company under the direction of Mr. J. B. Drinnan, later A.G.M. No. 7 Area. The work is being continued under the general direction of Mr. Torrance, the present A.G.M. No. 7 Area.

Discussion on Mr. Carr's Paper

W. A. Damon (Chief Inspector of Alkali, etc. Works, Ministry of Health) said that although Mr. Carr's claims regarding the effectiveness of trenching and the use of lime sludges, etc., were justified he thought he should not condemn other methods. The circumstances at each individual burning spoilbank should be considered and a decision reached as to which of the several available methods should be employed. Success could in fact most generally be attained by a judicious combination of several methods.

In his experience, good results had usually followed the continuous application of finely divided water. This method resulted in :

(*a*) a cooling effect by reason of the latent heat of evaporation.
(*b*) acceleration of weathering and disintegration of shale and clay.
(*c*) consolidation of the spoilbank by washing of fines into the interior of the mass.

Application of water to a very hot mass might result in the production of water gas. This being an endothermic reaction had a cooling effect and only if the water was wrongly applied was a spread of fire to be feared.

The extent of active fire should be ascertained by making a temperature survey. This might be done by lowering a maximum thermometer into pipes driven into the spoilbank and plotting the temperatures. Spraying should be commenced on the cool portions outside the area of fire and gradually advanced towards and into the fire.

Mr. Carr's supposition that spraying required an almost unlimited supply of water was misconceived. The ideal was to use a very fine spray and to apply just as much water as can be evaporated by the hot spoil. Good work had been done with 100 to 150 gallons per minute which were not abnormally large quantities.

Water spraying was particularly effective when properly applied to a comparatively open type of tip but it was very difficult to get water into the seat of a fire in the heart of an old well-weathered and consolidated tip. In such case water spraying would prevent nuisance but might not be sufficient to arrest the spread of fire which might be active at a depth of (say) 60 feet. Trenching was the only certain way of isolating fires in such tips but it could be an expensive operation which might not be justified unless valuable property was endangered.

Blanketing with limestone, sludge, clay, etc., would produce results if done thoroughly. Blanketing with sand was not to be recommended. Cracks would invariably develop in the blanket and these must continually be made good. The surface should be levelled off as far as possible so as to lesson wind effects.

Mr. Damon thought that it was most undesirable to overlay existing banks that had been on fire, with fresh spoil. Unless a temperature survey had shown that the material was inert, even a blanket of lime sludge as advocated by Mr. Carr was unlikely to prevent the new spoil from firing.

He was surprised that, having taken the trouble to separate pyrites from the refuse, Mr. Carr should cast them into a canal. He knew of several installations for the separation of pyrites which were then sold for the manufacture of sulphuric acid.

The fundamentals for fire prevention were exclusion of air and dissipation of heat. On this basis we could set forth means for controlling existing fires, as follows :

(1) Continuous fine water spraying through sprays placed strategically in accordance with temperature observation.
(2) Lagooning on the surfaces of flat spoilbanks. Reject washery waters, water softening sludge, etc., were useful for this purpose on account of their content of finely divided solid matter.
(3) Blinding with inert material.
(4) Isolation of the fire area by trenching.
(5) Construction of solid fire barriers by cementation or grouting.

Similarly means for preventing the incidence of fires were :

(1) Extension of the practice of underground stowage.
(2) Extension of the practice of dumping refuse at selected points on the sea coast.
(3) The more stringent removal of combustible material from spoil by picking of coal from large-sized dirt and suitable treatment of small-sized dirt and middlings to recover coal therefrom. Such methods had proved remunerative by reason of the recovery of coal, wood and scrap metal.
(4) The selection of suitable sites for spoilbanks, etc., low lying ground, quarries, etc., preferably near a source of water so that spraying might be practised if necessary.
(5) Separate dumping of large in-

combustible rocks and stones. If included with the small refuse these imparted an undesirable porosity to the spoilbank.

(6) Crushing of refuse and consolidation of spoilbanks to produce a dense mass into which air ingress was difficult.

(7) Provision of more than one tipping point so that each could be regularly and systematically rested and sprayed.

(8) The provision of temperature pipes in new spoilbanks so that any serious rise in temperature could be noted and checked, e.g., by spraying. Temperature records are also useful for the indication of improved conditions following treatment.

(9) Prevention of unauthorized picking on spoilbanks.

(10) The use of bulldozers for spreading refuse dumped from aerial buckets.

James Law (Chief Smoke Inspector, Sheffield) said that during the war years the Ministry of Health took over control of spoilbanks in order to prevent flaming and glare, and it must be admitted that from a nuisance point of view, though many of them showed overheating, they were infinitely better than had been thought possible.

Unfortunately since that control was lifted, conditions had worsened and had become so bad in the Yorkshire area that this special session was asked for in order that attention should be drawn to the nuisance caused, and that the National Coal Board be requested to abate the nuisances as soon as possible.

He thought the present method of pit-waste disposal was fundamentally wrong and that until a more practical effort was made, these burning spoilbanks would continue to be the disgrace to the community that they have been for years.

Colliery spoil would only burn so long as there was sufficient air to give combustion. If the air was excluded there was no overheating and little or no nuisance.

The present method of conical or aerial rope tipping was wrong because the small material was deposited at the top of the bank, the coarse material rolling to the base and giving easy access to unlimited air, so that overheating was certain to occur and reasonable control was impossible. In addition, these spoilbanks or " bings " were growing in height and size, some of them being over 300 feet in height and containing millions of tons of waste material.

In the vicinity of these banks due to extensive mining the ground had subsided, with the result that during the winter months, there were acres of boggy waste land which were just sites of abomination.

As an engineer, the only thing that could be said in favour of this method of pit waste disposal was that it was cheap. *It was cheap and nasty*, and little or no consideration had been given to amenity where it had been carried out.

It had been noted that where the embankment system had been carried out the prevalence to overheating was less and where overheating took place, control was more easily effected.

The only difficulty experienced with the embankment system was that the working faces were too deep, some of them being twenty to thirty feet.

Some years ago at Gin Pits near Manchester he saw a layering system of pit waste carried out and about thirty acres of good playing fields were laid on the top of this spoilbank.

He was quite sure that in the Yorkshire district alone, between Sheffield and Leeds there was ample opportunity of trying out a similar system and reclaiming an amount of boggy unusable land in the vicinity of the collieries.

He had been requested to move a resolution at this session on lines similar to that submitted to the Ministry of Fuel and Power in 1945 and to the National Coal Board in 1947. This, however, had been referred by the Executive Council to the Technical Committee for detailed consideration.

Thomas C. Wurts (Director of the Bureau of Smoke Control, Allegheny County, Pennsylvania, U.S.A.) in a

contribution read during the discussion had written to the Society as follows:

" One of the recognized major problems that must of necessity be solved in order to obtain a reasonable degree of smoke control in the County of Allegheny, Pennsylvania, is that of extinguishing coal refuse dumps (colliery spoilbanks) and of learning how to lay down this waste material without having it catch fire. A preliminary inventory indicates that there are a score or more of burning dumps within the more than 700 square miles of this County. Undoubtedly, there are several hundred other dumps, large and small, which for some reason or another have not seen fit to ignite, but which constitute an ever-present potential hazard.

" In this latter connection I might point out that we are familiar with a dump (fortunately not in Allegheny County) which had been dormant for about thirty years and which recently caught fire. In this particular case the situation was aggravated by the fact that a warehouse 120 feet long and 40 feet wide had been constructed on top of what was considered to be safe ground. Strenuous efforts are now being made to extinguish this fire with some indication of success.

" The Smoke Control Ordinance of Allegheny County for all practical purposes is a self-imposed Ordinance, and in this Ordinance the coal producers of Western Pennsylvania have imposed upon themselves the necessity of instituting scientific and engineering research to determine means of extinguishing the existing dumps and of laying down new dumps with a minimum danger of ignition.

" While the County Ordinance did not take effect until June 1st of this year, nevertheless, as early as January 1st the coal producers of Western Pennsylvania had already established a fellowship in the Mellon Institute of Industrial Research covering scientific investigations as to the causes of low temperature ignition of these dumps, and more recently have contributed on a 50 per cent. basis to engineering investigations in the School of Mineral Industries of Pennsylvania State College supplementing and implementing what is found at the Mellon Institute.

" It is to be expected that it will be necessary to treat the various dumps differently depending upon the sulphur, coal, slate, shale and other component parts of the waste. For example, we know of a dump where the waste, after a matter of months, disintegrates to almost a powder. In this particular instance lorry loads are dumped and at the end of about six months are levelled and compacted by the use of bulldozers, thereby consolidating the dump tightly enough to prevent the influx of air. Contrasted to this is another of such characteristics that, when a lorry load of waste from the washer is dumped, it may start to smoke in a matter of hours and certainly within a few days.

" In this connection I think it is pertinent to point out that, with the present-day practice of full seam mining combined with the development of the mechanized continuous mining machine, a great deal more material will be thrown on the refuse dump than was previously the case. In the case of hand-mining, the refuse to the dump averages 8 per cent.; whereas, with mechanical mining, the discarded refuse material runs from 25 to 35 per cent. May I call your attention to the fact that the capital expenditure of coal preparation facilities, sufficient to reduce this latter figure, would run into an amount that under present conditions would be uneconomical to say the least. Furthermore, as the result of legislation prohibiting stream pollution, all wash water must be neutralized before it can be released to the watershed.

" As of the present moment the problem is anything but solved. It is, of course, too early to make any statements as to the results attained. Suffice it to say that preliminary laboratory investigations at Mellon Institute have been most interesting, and in my humble opinion there is definite encouragement that a practical solution of this very difficult problem will be found.

" Should we be successful, I feel

sure that the information obtained will be made available through papers and otherwise to the coal industry throughout the world."

Councillor J. Forster (Whiston R.D.C.) said he spoke as a Colliery Engineer at Clock Face, where the spoil heap was on fire in 1936. Mr. H. Price, the manager, used slag from the company's iron and steel works 10 miles away. This was conveyed in wagons and spread over like a carpet and down each side and end 5 inches or 6 inches thick. When the rain came the slag was washed in and the fire extinguished.

Trouble arose with the farmer as the water on the land was unfit for his cattle after sifting through the heap. You could take a glass of milk from the cow, let it settle, pour most of the milk away and it would leave a fluid like red currant tea.

The Sanitary and Medical Officers took the matter up, and the company had to lay on town's water for the farmer. The ditches were cleaned and a trench laid around the heap to carry the water to the clay pit and on to the Sankey Canal.

Near by at Sutton Manor Colliery, Bold, there was a burning spoil heap to which the dirt was carried by aerial flight rope way. Tenants of houses built by the local Council in 1936 now complained of the sulphur fumes stench also dust in windy weather from the heap about 300 yards away. This could be treated in a similar fashion by using refuse from Pilkingtons Glass Works a few miles away which covers land suitable for other purposes. About ten or so other heaps are burning in this district but none as bad as the above.

G. W. Tate (Chief Sanitary Inspector and Housing Manager, Ashington U.D.C.) said since responsibility for control of burning pit heaps had been passed to local authorities it had only been "a quarter handled." A most disturbing trend in his opinion was the glib talk of what to do when starting new heaps. What was needed was elimination, not extension.

Quoting from the Annual Report of the N.C.B. for 1948, which he commended as a most interesting document, he referred to part of the work of the Scientific Department, which was the almost day to day examinations of the 8,000 sizes and grades of coal marketed. This task he suggested might well be telescoped and a Division of the Department set up to deal with the question of pit heaps.

There was more than 7,000,000 tons of spoil in Ashington, increasing daily. Extension of present heaps, creation of new ones, or tipping on the coast at high water mark were no answers to the problem. The Board's scientists must get down to an examination of the spoil to see what uses, if any, it might have.

In the meantime let the heaps be controlled by all possible means so that further excrsecences would not despoil our green and pleasant land. One question he posed to Mr. Carr was. How did the limestone dust blanket behave in a high wind?

Councillor O. Inman (Stocksbridge) said he was concerned with burning spoil heaps composed of mixed refuse from a colliery and from a large steelworks. Each fire had required somewhat different treatment. For example one fire used over 5,000 tons of stone dust to fill completely all the voids which provided the air for combustion. The only general rule had been isolation by excavation to natural ground and this had sometimes involved going as deep as 80 feet.

Other causes of fire than the one mentioned by Mr. Carr had been found to be—

(*a*) Burning of rubbish or children's bonfires.

(*b*) Restrictions of natural ventilation by (i) snow, (ii) erection of buildings.

(*c*) The stocking on the spoil heap of oil impregnated metal borings.

Had the speaker any knowledge of controlled explosives for the extinction of tip fires, also what precautions did he recommend to avoid accidents resulting from large voids left near the surface by burning refuse?

It was Mr. Inman's opinion that spoil heaps should be made in the

manner recommended by Mr. J. W. Call, Director of Public Cleansing for the City of Bradford in his paper on "The Practice of Controlled Tipping."

Dr. R. Lessing (Chairman of the Technical Committee, N.S.A.S.) in a written contribution said that the accumulation of colliery refuse was objectionable from every point of view. The spoil heaps turned green fields into eyesores; they encroached further on the already limited land available for agricultural use; they were a menace to health and amenities of life by giving off fumes of tarry matter and sulphur oxides; they sometimes involved fire hazards to adjoining property. Not only were they a nuisance to the neighbourhood, but also to the collieries themselves, who incurred expense in the transport and lifting of vast quantities of material and the provision of ground on which to deposit them.

The methods hitherto employed in dealing with existing spoil heaps which were "heating" or on fire, must be regarded as mere palliatives. The notorious worsening of conditions during recent years and the increasing rate of accession of refuse called for a more determined attack on the fundamentals of the problem. What was wanted was prevention rather than cure.

In his view, the most logical treatment of the refuse was to burn the combustible contents of the refuse under control in appliances specially designed for the purpose. He had proved that this could be done successfully. In the first plant for cleaning coal by gravity separation all the steam required was raised by combustion of the dirt removed from the raw coal. If this were done on an extensive scale, in modern plant, two important objects would be achieved:

(1) The ash residue of the colliery waste would lose its liability to spontaneous combustion and could be safely used for underground stowage, thereby helping to prevent subsidence and, at the time time avoiding the further enlargement of spoil heaps.

(2) The realization of the heat value in the refuse would be an important factor in the economy of coal cleaning. It was pointed out in recent special articles in *The Times* on "The Quality of Coal" (August 2nd and 3rd, 1949) that such utilization would curtail the loss incurred by discarding a certain tonnage of washery refuse and thus promote the preparation of clean coal.

Admittedly it would not be easy to deal with existing spoil heaps on these lines, as it would involve double handling of a material of largely unknown composition. The treatment should, therefore, be applied in the first instance to the freshly produced refuse coming up from the colliery or washing plant, so that, at any rate, the addition of nuisance-creating matter would be avoided in the future.

F. C. Marrison (Deputy Director of Scientific Control, National Coal Board) said that although Mr. Carr had concentrated his attention upon the treatment of burning spoil heaps in a manner which was not in general use throughout the country, he had also touched upon the methods which were more widely employed. The problem in Leicestershire and South Derbyshire which was the treatment of spoil heaps in the absence of water supplies, was the most difficult of all. A paper dealing with this method of tackling the problem was deliberately chosen as it was thought that the Conference would be interested to hear in greater detail what was being done under such conditions, rather than a more general and diffuse treatment of the subject. Water sprays were, however, the most common method of treatment and at the present time some 90 per cent. of the burning spoil heaps were being treated in this way.

Previous speakers had made a considerable number of suggestions, many of which were in fact at present being used. These served to emphasize that the problem was a most complicated one. It was indeed not a single problem at all but rather a collection of more than a hundred individual problems, since each spoil heap must be treated on its merits depending on the individual

circumstances. Mr. Damon had set out in a clear and concise manner the various methods of treatment which could be employed. These could be considered under two main headings—reduction of the temperature of the material and the exclusion of air necessary for promoting combustion. A combination of these methods of attack was frequently used although in the absence of water the former was most difficult. There was no easy solution but apart from treatment of existing sources of trouble, active consideration was being given to stacking waste material in such a manner as to prevent combustion.

Suggestions had been made that attempts should be concentrated on finding profitable uses for the material in spoil heaps. These suggestions did not make allowance for the huge quantity of material in the spoil heaps nor of its undesirable characteristics. By its very nature, which led to spontaneous ignition, it was in general most unsuitable for constructional purposes although it would be used where practicable.

Mr. H. Taylor (Blackwell R.D.C.) said that there was a lot of carelessness in the mines; tubs were half filled with coal and then topped up with muck.

In the old-fashioned days of mining the miner disposed of his dirt in the pit, but under the highfalutin' system of mechanization he had not the time to do it.

Colliery managements, faced with the problem of reducing expense, cut down on the number of surface workers and the spoilbanks were allowed to spread. What with cemeteries and spoilbanks there would be no place for the cattle to graze in a few years' time! The money which went on repairing houses and roads damaged through mining subsidences should be spent on devising methods of keeping the dirt in the pit.

J. Stafford (Divisional Chief Engineer, National Coal Board, N.E. Div.) said that it was not practicable to apply, at the larger collieries, the method described by Mr. Carr, and continuous water spraying was universally adopted. He had no need to enlarge upon water spraying, as Mr. Damon had so fully described it and other remedial measures being actively taken by the National Coal Board. He took the opportunity to express the appreciation of all responsible colliery officials, of the practical advice and help they receive from Mr. Damon and his District Inspectors.

He assured the Conference that the National Coal Board were fully alive to the importance and urgency of the subject, and said that they had recently required all areas to give an account of what remedial measures they were taking. The Board also recognized that prevention was better than cure and were taking steps at both old and new pits to ensure that spoil tips should be conglomerate masses not predisposed to fire. He referred to an excellent survey of spoil tips in his own Division, made by the West Riding County Planning Department in 1948, which provided a valuable basis for review of the effect of the measures being taken. A recent survey taken by the N.E. Divisional Board indicated that on the whole fewer tips were now burning than in 1948; an encouraging position which the Board intended to improve upon.

Arthur Bates (County Planning Officer, West Riding of Yorkshire C.C.) in a written contribution stated that delegates very quickly got off the problem of burning spoilbanks on to colliery spoilbanks in general, and it was clear that there was a very strong and critical attitude amongst the delegates towards the National Coal Board and their efforts in this direction. They had given a considerable amount of thought to the matter in the West Riding, and he had come to the conclusion that, while it did not wholly cover the problem, the most practical contribution that they, as a Planning Authority, could make, was to agree with the National Coal Board on certain basic planning conditions, which would be applied to all new pit heaps within the Administrative County.

In this connection, doubtless, dele-

gates would be aware that the terms of the Town and Country Planning Act allowed the County Council, as the County Planning Authority, to make conditions in respect of the construction of new heaps but that existing colliery spoil heaps were, for the time being, excluded from these requirements. They had, accordingly, agreed in general principle with the officers of the National Coal Board that they might expect from them in all ordinary cases of the construction of new spoil heaps that certain conditions would be imposed. Their principle was that no conical heaps would be permitted excepting in the most exceptional circumstances, and those he did not anticipate would ever arise. In general, the long and embankment type of heap was favoured, and those, in this area, because of the immense quantities of material involved, would usually rise to a height of about 200 ft., and have a length of possibly up to half a mile. The system of tipping would be that as the tip was made a bulldozer would be employed to spread out the tipped material so that the slope was reduced from about the normal 1 in 1... to about 1 in 3 and that as the tip moved forward, earth to a depth of about 1½ft. 9 ins. would be re-graded over the flattened slopes by the bulldozer. Thus the restoration of the heap to agricultural land would follow progressively behind the face. The earth for the covering of the tip would be taken out from under the site of the tip in advance of the face of the heap and stacked at the side of the toe of the heap until the heap had moved forward to such a point that the earth could be replaced.

This system, they believed, would either prevent or greatly reduce the liability of firing in the heaps in two ways. First the action of the bulldozing would consolidate the heap before it had time to fire and, secondly, the backfilling of the earth would seal the heap from the air. As the reclamation moved forward the surface would be seeded down with a suitable grass seed. It was recognized that the land so reclaimed would probably never be anything better than rough grazing land, but that was, in his view, a secondary matter. It was not believed that the area of land taken up would be materially greater than by the old method because under the old tips there was always a considerable area of land around the base of the heap covered with boulders and debris, and the area would be sufficient to accommodate the flattened heaps. They had already received applications from the National Coal Board for consent to tipping based upon the new system, and he felt that it might be of some interest to know that in this County some positive move has been made towards the problem of dealing with these unsightly obtrusions on the landscape. The relationship between the National Coal Board officers and his Department was excellent and the results were being achieved by friendly co-operation and not by any undue pressure.

J. Carr, replying to the discussion, said that Mr. Damon had stated that he did not seem to agree that water spraying was of real value. In the Paper, however, he had said that "the secret of spraying lies in that term 'continuous spraying'." The method of so applying water was well tried and proved where there was a plentiful supply. It had to be pointed out that the Paper dealt with an area where water supplies were very restricted.

In replying to the point on the separation of pyrites, Mr. Carr said that the pyrites in question were of very poor quality and had little or no commercial value.

THE WORK OF THE FUEL RESEARCH STATION OF THE D.S.I.R.*

by

A. PARKER, C.B.E., D.Sc.

Director of Fuel Research

Introduction

BEFORE the 1914-18 war, scientists in Great Britain received very little encouragement either from industry generally or from the Government. They were looked upon as somewhat peculiar individuals, who might have their value on occasion, but were not usually capable of dealing realistically with everyday affairs. In such environment only those studied science, who had faith in the value of scientific method and knowledge, or who were so keenly interested in science that they were prepared to forego the better material prospects in other fields of activity. In consequence, our scientists of that time were of high average ability, but they were few in numbers—much fewer in relation to the size of the population than in Germany. They were building up a fund of knowledge of great value, but the results of their work were not being greatly used in British industry.

One reason for this state of affairs was that Great Britain, in the 18th and 19th centuries, had no difficulty in leading the World in establishing great industries, on the basis of her good reserves of coal as a source of heat, light, and power, to facilitate and supplement manual labour. During the period of 150 years from 1750 to 1900, the annual production of coal rose from about 5 million tons to 220 million tons and the population increased from 8 millions to 37 millions. Without this change from primarily an agricultural to mainly an industrial country, it would have been impossible to support the rapidly increasing population at a standard of living that also rose. Annual output of coal continued to increase until 1913, when there was a record production of 287 million tons. Most of the coal was used at home, but there was a surplus for export, which reached 70 million tons in 1913. In return for our exports of coal and industrial products, we were able to import food and raw materials.

During most of the 19th century, Great Britain had an easy lead in industry with no great competition from abroad. By 1913, however, industry on a considerable scale had been developed in some other countries in Europe and America with good reserves of coal. The U.S.A. had also taken the lead in the production and use of petroleum. Competition had become keen. Coal of excellent quality was plentiful and could be obtained at a low price. The price was indeed too low, In consequence, coal was used wastefully, bringing with it pollution of the atmosphere by smoke and grit; and much useful fuel was discarded in colliery dumps.

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* *See illustrations on p.* 39.

Then came the war of 1914-18. The demand for fuels of all kinds increased, but partly owing to the calls on man-power, annual production of coal in Great Britain fell from the 287 million tons of 1913 to 225 million tons in 1918. With the greater demands on coal supplies in relation to the quantity produced, and the need to import large quantities of oil under difficult conditions, the importance of fuel, not only in war but also in time of peace, came to be more generally recognised. Though our reserves of coal underground were considerable, they were not inexhaustible. We were drawing on the seams most easily accessible, so that difficulties of coal production were likely to increase. Further we had no indigenous petroleum and we might be faced with making large quantities of oil from coal or using coal in place of oil for those purposes for which it was specially suitable. It was agreed that scientific research should be brought in to solve the many problems and to show the way to the more efficient use of fuels.

It was decided by the Government that a central Fuel Research organization should be established. At about the same time the Government also decided that if we were to maintain a prominent position in world affairs and industry, there must be a great expansion in our scientific research generally and in the application of the results. To implement this policy, the Department of Scientific and Industrial Research was established. One of the first activities of this new Department was to appoint, in 1917, a Fuel Research Board with the late Sir George Beilby as Chairman and Director of Research.

The determination behind the move was such that within two or three years, a central Fuel Research Station equipped for experiments in the laboratory, on an intermediate scale and on a commercial scale, had been built on the site of several acres at East Greenwich. The terms of reference were wide. The organization was given the task of investigating, in the widest national interest, the nature, preparation, utilization, and treatment of coals and other fuels and of products derived from fuels. It is interesting to note that two items of prominence in the initial programme were the production of smokeless fuels, with the objects of improving fuel efficiency and of reducing the pollution of the atmosphere by smoke, and the production of oil from coal. The programme as a whole was planned to ensure a balance in fundamental and applied research to cater for long-term and short-term investigations, with arrangements for co-operation with Universities and with industry. Though there had been scientific investigations of fuel problems in Universities and in industrial undertakings, the setting up of the central Fuel Research organization was in itself an experiment, for nowhere else in the world at that time was there an organization on quite the same lines.

Since the establishment of the organization about 30 years ago, the work of the Research Station at Greenwich has been steadily developed. The number of staff is now about 250, including about 60 graduates in chemistry, engineering, and physics, and more than 100 industrial workers. The results of the many investigations have been published in numerous official documents and in papers presented to appropriate scientific and technical Societies and Journals. In a short paper, it is possible to do no more than refer to a few of the investigations and the results obtained, to indicate the scope of the work.

Coal Survey

As coal is the principal fuel in Great Britain, it is natural that more attention has been devoted to coal and its products than to other fuels and their products. It was soon realized by the Fuel Research Board that though there were estimates from geological investigation of the quantities of coal underground in the different coalfields, there was little systematic information on the physical and chemical properties of the coals in the many seams. Coal varies widely in characteristics not only from one coalfield to another, but also in the same coalfield and often in the same seam. Each type of coal has its own particular chemical and physical proper-

ties. One type may be well suited for certain uses or industrial purposes, but it may be quite unsuitable for other purposes. For example some coals are especially suitable for the production of metallurgical coke, while other coals are unsatisfactory for that purpose. Some coals are of special value for the manufacture of town gas and others for producer gas. Many examples of this kind could be given. It is not practicable to allocate coals solely from consideration of their special properties. Other factors, such as cost of transport and availability of supplies must also be considered. It is impossible, however, properly to allocate our coals for use in the best national interest, taking both the short-term and long-term views, unless there is trustworthy information on what kinds of coals we have, where they are, in what amounts, and to what extent they can be economically worked.

For these reasons the Fuel Research Board early began a systematic physical and chemical survey of the nation's coal resources. Survey Laboratories were set up in all the principal coalfields. By 1947, after the survey had been in progress for about 25 years, the number of staff employed in these provincial laboratories was about 90. The work included not only examination of the coals as they occur underground, but also of commercial grades as produced by the collieries. By 1943, it was decided that sufficient information—though incomplete—had been collected to justify a beginning in an extension of the work to relate type of coal and quality to the quantity in reserve. The first simple evaluation of data obtained in relation to coal in reserve that is likely to be raised during the next 100 years was published in 1946 as Fuel Research Survey Paper No. 58. In that paper a system of classification was introduced, that has now been adopted by the National Coal Board. It was shown that, provided there is intelligent allocation, it is unlikely that there will be a serious shortage of any one of the several broad types of coal in reserve underground within the next 100 years. It is important, however, that coals of very special properties, such as those from which metallurgical coke of the highest grade can be obtained, should be reserved as far as possible to meet the special requirements; they should not be squandered by using them for purposes for which other more plentiful coals are equally suitable.

As a result of this survey there is more information about the coals of Great Britain than there is about the coals of any other country. In 1947, the Coal Survey Laboratories with their staffs and equipment were transferred to the National Coal Board, who have undertaken to carry on and extend the work of the survey and to continue the policy of publishing the results.

Coal Preparation

Coal, as produced at the Collieries, is not always in a form most suitable to meet the various industrial and domestic requirements. It consists of pieces of various sizes from large lumps down to fine dust, and it may contain excessive amounts of incombustible matter. It has long been the practice at many collieries to grade the coal by screening into various sizes, to remove much of the larger pieces of shale and stone by hand-picking, and to remove smaller particles of incombustible matter by special processes of cleaning. As the more easily worked seams of coal become depleted, seams which do not so readily provide clean coal have to be exploited. Extension of coal cutting by machine and mechanical handling to reduce manual labour also increases the amount of dirt brought up with the coal and the proportion of fine coal. In consequence, the need for developing and applying satisfactory and economical methods of coal cleaning increases in importance, especially methods of cleaning fine coal. In selecting the best methods of cleaning the different types of coal, account must be taken of the particular physical characteristics, especially the size and surface properties of the coal particles.

Until recently, laboratory studies of the physical properties of coals, followed by investigations to the scale of treatment of several tons an hour, have

occupied a prominent part in the work of the Fuel Research Station. The investigations were often continued at collieries with the assistance of the staffs of the Coal Survey Laboratories and the co-operation of the colliery undertakings. In addition, investigations have been undertaken on the cleaning of coals from the Commonwealth countries, to assist those countries in the exploitation of their coal resources. With the development of the scientific work of the National Coal Board, the part played by the Fuel Research Station in this field of activity is being reduced. The Research Station now deals only with some of the more fundamental problems and with special investigations, such as the treatment of coals of different types from the Commonwealth countries, and the production of specially cleaned coal or anthracite for the manufacture of electrode carbon.

Carbonization and Gasification

Over a long period, extensive investigations have been undertaken on the carbonization of different coals, including some from overseas, at high and low temperatures, with the object of determining the effects of changes in conditions on the quantities and properties of the coke, gas, tar and other products obtained. The work has covered the whole range from experiments in the laboratory to experiments with full scale plant at the Research Station, at gasworks, and with commercial installations of coke ovens. Systems of low-temperature carbonization for the production of smokeless fuel suitable for the domestic open fire have been develped at the Research Station. In addition most of the low-temperature carbonization plants developed by commercial enterprise in Great Britain have been investigated and tested and the results have been published. Experiments are now in progress with the object of ascertaining the possibilities of producing relatively reactive coke, suitable for the newer domestic appliances, by modifications of processes of high-temperature carbonization. There is little doubt that under certain conditions of high-temperature carbonization, cokes entirely satisfactory for the newer domestic appliances can be produced. One important point is that the cokes should be of suitable grades of size.

Systems of manufacture of producer gas and water gas from coke, and carburetted water gas from coke and oil have been extensively studied from the stage of experiments in the laboratory to full-scale plant at the Station.

At the present time experiments are in progress to ascertain the possibilities of the complete gasification of coal, particularly fine coal, for the manufacture of producer gas, water gas, and gas suitable for the synthetic processes of making oil.

Boilers and Furnaces

Though the main types of industrial boilers for raising steam have been in use for many years, the problem of firing them efficiently and without the discharge of smoke and grit into the atmosphere still provides great scope for the fuel technologist. Conditions for the most efficient operation depend not only on the design of boiler and stoking equipment, but also on the type and size of coal or coke. With hand-fired boilers of the kind in use in many industrial works, efficient combustion with the emission of little smoke can only be obtained provided that there is controlled admission of secondary air. Within the last few years, as a result of extensive experiments with the full-scale boilers at the Fuel Research Station, there has been developed a simple and inexpensive device whereby the emission sion of smoke from hand-fired boilers of the shell-type (e.g., Lancashire) is eliminated or greatly reduced, while at the same time the efficiency of the boiler is increased by several per cent. This equipment, which is simple to operate and is easily fitted to the boiler, has been tried in industry and is now being manufactured by several commercial firms.

During the recent war, the Research Station was asked to investigate the possibilities of eliminating or greatly reducing the smoke from the coal-fired marine boilers of merchant ships. Smoke from such ships in convoy dis-

closed their position to enemy aircraft and submarines, even beyond the horizon. The problem was studied, and series of experiments were first undertaken with the hand-fired Scotch marine boiler at the Station. One important point was that any equipment devised should be simple to make and to fit to ships' boilers, and easy to operate. Equipment meeting these requirements was developed and was fitted to the boilers of more than 1,000 ships with satisfactory results. Since the war, tests on the marine boilers at the Station, and tests by the research staff on the boilers of a merchant ship during a voyage of several weeks, have shown that with the average type of bunker coal, not only is smoke emission almost eliminated, but the concumption of coal is reduced by 5 or 6 per cent. It is important to note that in the tests on the ship the boilers were fired by the ordinary crew of firemen.

With many of the boilers in use at electricity power stations for raising steam at high pressures and temperatures there has been serious trouble from the deposition of solid matter on the external side of the heating surfaces and from corrosion of the equipment for preheating the air supplied for the combustion of coal. With some boilers, the amount of solid matter deposited has been so great that the boilers have had to be shut down for extensive cleaning after having been in continuous operation for only a few weeks. Without this difficulty, it should be practicable to keep the boilers in continuous operation for a year before shutting down for inspection and cleaning. The effect of this trouble has been particularly marked during the last few years, with the greatly increased demand for electricity, and the shortage of generating plant. At the request of the electricity industry and the boiler makers, the Fuel Research Station and the British Coal Utilisation Research Association are co-operating with the industry in an investigation of the problem. The task allotted to the Fuel Research Station has been to ascertain the effect of the type and composition of the coal used in relation to the design and method of operation of the boiler installation. It has already been proved that there is a definite relationship between the severity of the trouble, the nature and amount of the inorganic substances in the coal, and the conditions of operation. For example, coals containing unusually high amounts of alkali chlorides or of phosphorus give marked trouble when fired with mechanical stokers of the coking type. Though coals rich in phosphorus contain only 0.05 per cent., some of the deposits collected have contained as much as 10 per cent. of phosphorus There has been relatively little trouble of this kind with boilers fired with pulverized fuel. The results have shown how the difficulties can be greatly reduced by modification in the allocation of coals and by some other changes. Improvement in the availability of the boilers at generating stations has already been effected.

Within the past 30 years there has been steady development in the use of pulverized coal for firing boilers and furnaces. One reason for this development is that when burned under suitable conditions, pulverized coal gives to the coal-fired furnace some of the advantages of flexibility usually associated with oil firing. Another reason is that small coal, which is necessarily produced in considerable quantity, particularly with the increased mechanization of coal mining, has been sold at a much lower price than coal of larger size. A considerable amount of work has been undertaken by the Fuel Research Station on pulverized fuel firing. The first Fuel Research Technical Report, published in 1919, was on this subject. The experiments have covered not only methods of pulverizing, but conditions of combustion from individual particles in laboratory equipment to burners of special design, each using several hundred pounds of coal per hour. Special designs of " grid " and " multi-jet " burners have been developed and are now in use in a variety of furnaces in industry.

A special " Vortex " combustion chamber was designed before the recent war and was used in experiments to a

scale of burning up to 500 lb. of pulverized coal per hour, with the high heat release at atmospheric pressure of 0.5 million B.Th.U. per hour per cubic foot of combustion space. The object of those experiments was largely to develop a new combustion chamber for boilers for raising steam.

In another series of experiments, in co-operation with industry, stable mixtures of powdered coal and petroleum fuel oil were prepared and studied in small-scale and large-csale experiments in which this so-called colloidal fuel replaced fuel oil. Following full-scale experiments with the boilers at the Fuel Research Station, a member of the Research staff took part in trials in which this kind of colloidal fuel was used to fire boilers on a large ship during a voyage to New York.

Combustion for Gas Turbines

Intensive experimental work is in progress with the object of ascertaining the possibilities of using coal in place of oil as the source of energy for gas turbines. A new Vortex combustion chamber, with cooling by air, has been designed to burn 500 lb. of pulverized coal per hour. If the experiments are successful in satisfactorily burning powdered coal at atmospheric pressure they will be extended to the combustion of the coal at a pressure of several atmospheres. It is hoped that it will be possible in equipment of the same size to burn 2,000 lb. of coal per hour, to give a heat release of the order of 2 million B.Th.U. per hour per cubic foot of combustion space. The work also includes the problem of cleaning the gaseous products of combustion to remove excessive amounts of solid matter that might otherwise damage the turbine.

Another branch of this programme includes experiments on the production and combustion of producer gas under conditions suitable for providing the energy for gas turbines.

Oils and Chemicals from Coal

Extensive explorations during recent years has failed to reveal any appreciable reserves of natural oil in Great Britain. World reserves of oil may be large, but it is fairly certain that they are not nearly so great as world reserves of coal. That is why several countries are now interested in processes of obtaining oils from coal. The Fuel Research Station have been interested for a long time.

Coal carbonization is one way of obtaining oils as a by-product from coal, with coke and gas as the main products. In this way up to about 20 gallons per ton of coal can be obtained. There are two types of process, however, in which oils are the major products. In the first, coal is treated with hydrogen at temperatures in the region of 450° C. and at pressures from 200 to 700 atmospheres. This process was introduced in Germany, where the first commercial plant was started at Leuna in 1927. By 1944 there were 18 large plants in Germany producing oil at a combined rate of 3.5 million tons a year. At that time most of the German aviation spirit was made by hydrogenation of coal or coal tars. Experiments on this type of process were begun at the Fuel Research Station as early as 1923, using British coals, and they were continued for about 15 years to the stage of treating one or two tons of coal or tar per day. Experiments were also undertaken by Imperial Chemical Industries, who have had a commercial plant in operation since 1935 producing between 75,000 and 150,000 tons of oil a year, mainly from coal tar creosote. There has also been much experimental work at the Fuel Research Station on the hydrogenation of coals from other parts of the Commonwealth.

In the second main type, the Fischer-Tropsch process, coal is converted by various methods into a mixture of the two gases carbon monoxide and hydrogen. The mixture is purified to remove sulphur compounds and is then passed over special catalysts containing cobalt or iron for the synthesis of hydrocarbon oils and waxes. This process was developed in Germany to the scale of production at a rate in 1944 of about 600,000 tons of product a year. The process has been under continuous investigation at the Fuel Research Station since 1934, in the laboratory and

on a rather larger scale. There is no doubt that the technique adopted in Germany can be greatly improved. No commercial plant has been erected in Great Britain. On a cost basis, neither the hydrogenation of coal nor the Fischer-Tropsch type of process can compete with natural petroleum at the present time. The reason for their utilization on a large scale in Germany was the war-time need to be independent of imported petroleum, as far as possible. With coal at its present price in Great Britain, the oils from these processes as so far developed, would cost 2s. to 2s. 6d. a gallon at the plant. There are, however, possibilities of improvement, and there are parts of the Commonwealth where coal of certain types can be produced at a price as low as about 5s. per ton. It may be that in the not far distant future there will be a serious shortage of petroleum oils. It is for these and other reasons that it has been decided to extend and intensify the work of the Fuel Research Station in this field.

Domestic Heating and Cooking

Shortly after the establishment of the Fuel Research Station, investigations were begun on the use of different solid fuels in domestic fires. During the last few years, the Station's work in relation to domestic heating and cooking appliances using various fuels, particularly coals and cokes, has been very greatly extended. Before the recent war, about one third of the coal used in Great Britain was used as such, or indirectly as gas and electricity for space heating, cooking, and hot water supply in our houses. Yet the average standard of heating was low, because the efficiency of most of the coal burning appliances was no more than 20 per cent. The intensive research and testing work in progress at the Research Station, in co-operation with other Government Departments, housing authorities, and appliance manufacturers, aims at greatly increasing—at least doubling—the average efficiency in ordinary household use while providing appliances that are easy to instal, simple to operate, of pleasing appearance, and not too costly. An effort is also being made to reduce the amount of atmospheric pollution by smoke from domestic appliances. To assist in the work, a branch of the Fuel Research Station has recently been established at East Kilbride, near Glasgow, in which area about half of the appliances burning solid fuels are made.

The equipment at the Fuel Research Station includes specially designed " calorimeter rooms " and laboratories in which the more fundamental problems of domestic heating and of methods of testing appliances are being studied.

Atmospheric Pollution

Under the guidance of the Atmospheric Pollution Research Committee, which is now a Committee of the Fuel Research Board, methods of measurement of different forms of atmospheric pollution have been improved and new methods devised. Systematic records of the extent of pollution in many parts of the country have been obtained over a long period of years, with the assistance of Local Authorities and others interested. The results of these measurements and of special investigations have been published in a series of reports. Over a period of three years an intensive survey of pollution in a selected area, Leicester, was undertaken ; this survey has provided valuable information on the factors affecting the movement and dispersal of pollution. This work in relation to the incidence of atmospheric pollution is still being extended. There are now about 70 authorities co-operating with the Fuel Research Station in making daily and monthly observations in many parts of the country. More than 500 instruments are in use for measuring deposited solid matter, pollution by smoke, and sulphur, and intensity of daylight. One special investigation by the Research Station is concerned with the incidence of pollution by sulphur in selected areas. All these activities are closely linked with other work of the Fuel Research Station on methods of reducing the emission of polluting substances from the burning of fuels, and of improving fuel efficiency.

Miscellaneous Investigations

There have been numerous miscel-

laneous investigations, some on an extensive scale, to meet the need not only of this country but of the Commonwealth countries overseas. They have included work on the winning and utilization of peat; production of oil from shale; the extraction of special waxes from lignite and peat; the use of waste materials such as sawdust, flax shives, and ground nut shells as fuels; production of active carbon; orchard heating to prevent damage to fruit crops by frost; and many other items.

War Work

During the war extensive use was made of the knowledge and experience of the staff and of the facilities of the Research Station. It has already been mentioned that the organization developed the equipment fitted to more than 1,000 merchant ships to prevent emission of smoke from ships in convoy. One activity was aimed at producing smoke in certain areas as a means of camouflage.

As an extension of work begun before the recent war, mobile gas producers were designed for motor buses, commercial vehicles and cars. These producers used anthracite and coke to replace petroleum, and large numbers of vehicles were equipped with them. In addition to the experimental work at the Station, the staff made tests covering more than 250,000 miles on the road with vehicles of several types, including a London bus. There were also trials with agricultural tractors.

It is generally known that the flame-thrower fuels used by our Army were greatly superior to any tried by the enemy. These fuels, which can be aimed over considerable distances without undue dispersion, to burn at the target, were developed at the Station; they were known as F.R.A.S. fuels. Apart from their wartime use, they are scientifically interesting because of their peculiar properties of viscosity. There was other work also on coastal flame defences and on incendiaries.

Equipment at the Station has long included full-scale plant for the manufacture of hydrogen to provide this gas for various investigations. In consequence, the staff were called upon to take a prominent part in advisory and other work in the installation and operation of plants erected in various parts of the country for the production of hydrogen for barrage balloons. The plant at the Station was continuously operated as one of the manufacturing centres. It provided sufficient hydrogen to fill completely 11,000 balloons.

A prominent part was played in investigating problems of recovery of motor benzole from the coal gas made at coke ovens and at gas works. Production of motor benzole steadily increased during the war to about 100 million gallons a year.

One urgent requirement during the war was sulphur for the manufacture of sulphuric acid, so much used in the production of explosives. The research organization co-operated in work on the recovery from coal of large quantities of pyrites for the manufacture of sulphuric acid, thus reducing the quantity of pyrites that had to be imported. The Coal Survey Laboratories assisted in this work; they also played a prominent part in guiding the selection of sites and operations for the production of coal by methods of opencast mining.

Information Service

There is a well-established information and library service at the Research Station at Greenwich to assist all who are interested in fuel problems. The service includes the publication of monthly summaries, under the title "Fuel Abstracts," each containing an average of about 1,000 abstracts of the scientific and technical literature, both British and foreign. In the preparation of these abstracts the Research Station is in close co-operation with the fuel industries and their Research Associations.

Concluding Note

As mentioned in the introduction, this short paper can do no more than give an indication of the scope of the work of the organization, which has a big programme ahead. There is so much of importance in the broad national interest to be investigated in relation to fuels and their products, that

only those items of greatest importance can be tackled during the next few years. Throughout, the work is planned to ensure a good balance in fundamental research, applied research, and development. There is close collaboration with other research organizations, industry, and the Universities, with the object of ensuring that there is no undesirable duplication of effort and that the available scientific manpower and talent in this field are effectively used.

As a central Government organization, the Fuel Research Station is there to serve industry and the community generally, in the interests of Great Britain and the Commonwealth countries overseas, in the widest sense.

Discussion on Dr. Parker's Paper

F. J. Redstone (Chief Sanitary Inspector, Bristol), said it was obvious everyone had been thrilled by the address given on the work carried out at the Fuel Research Station and he could confirm the ready welcome given to visitors and the interesting results of the work performed there. Dr. Parker had referred to the new smoke eliminator doors which had been invented by his department for use with natural draught boilers, and he asked whether similar apparatus for the elimination of smoke was being or could be constructed for cases where artificial draught is employed.

A. McCartney (Chief Sanitary Inspector, Wrexham) spoke as a delegate representing a small Authority, where the Penny Rate realised approximately £650.

In connection with the installation of instruments for measurement of Atmospheric Pollution, Mr. McCartney stated that his Authority did not object to the initial cost of installing the necessary instruments in Wrexham, and as a matter of fact they had agreed in principle to setting up two deposit gauges and five lead-peroxide cylinders at a cost of approximately £30. What his Authority did find of more concern was the cost of monthly analyses of these instruments and he would be glad if Dr. Parker could give him any idea as to whether his Department would consider the setting up of regional laboratory facilities where small authorities could have analyses carried out at a more reasonable cost.

Councillor Mrs. M. Martin (Aireborough U.D.C.) said she was very glad that Dr. Parker had been doing something to help the improvement of domestic appliances. But she would like to ask him if he thought it was enough.

The oven they had just seen was a very poor arrangement and she wondered why they should always have to bend down to use it. They wanted eye-level ovens, in attractive colours and of good design, not with horrible legs and difficult to sweep under.

There were about 20,000,000 domestic stokers in this country—wouldn't use the word housewife; it led to trouble! They had heard of the attention given to the training of boiler firemen in industry, they had classes for instruction and the latest equipment. There was no such way to train the domestic stoker and yet they were blamed for 70 per cent. of all smoke, and theirs is the smoke with tar and all the other by-products in it.

The proportion of Council to private houses was 1-8 over the country; in her district it was about 1-6. There was control over smokeless equipment in the Council houses, but in her work

on the Housing Committee she heard many complaints about it. There was no way to educate the private householder except by example and providing the best designs and colours.

She had collected all the illustrations from the bookstall outside. They looked good at first but she had found from personal experience that there was at least one big snag to them all.

In one instance the front opening was not wide or deep enough to take a shovel of fuel, the shovel being of the size supplied by the makers of the stove and supposedly correct. What happened? The coal spilt on to the floor, there was a mess and grumbling, and if they had to pester their husbands into buying the stove they would not do so again for another room.

She was in the middle of installing central heating; there was an awful mess at home and she did not think they could all be expected to do that just now, however much they wanted to avoid smoke.

She returned home from the conference yesterday feeling full of enthusiasm and rang up the shop where she had had a coke water heating stove ordered since about May. This firm made only battleship grey and she wanted cream; why not after all these grey years? Last night they told her that she could not have cream as they could only do the one colour. She didn't believe that, but after all these weeks of trying to get attractive efficiency she was no further; in fact she was the reverse; and this morning she was so irritated that she threw a shovelful of coal on her open coal range and she hoped it was still smoking.

Much had been said about the psychological appeal of the open fire. This was so strong a tradition that if the experts were going to educate them away from it they must provide something that was as good, if not better in every way, and she did not think they were anywhere near that yet.

Dr. A. Parker in replying to the discussion dealt first with the question raised by Mr. Redstone. He said that up to the present smoke eliminators had been developed at the Fuel Research Station for use with hand-fired Marine boilers, both natural-draught and forced draught, and for hand-fired Lancashire boilers with natural-draught. Work was now in hand to obtain data for the design of smoke eliminators suitable for forced draught hand-fired furnaces of shell type boilers, including Lancashire boilers. Work was also proceeding for the development of smoke eliminators for hand-fired vertical boilers.

He appreciated the point raised by Mr. McCartney, but was of the opinion that it would not be economic for the Department to set up Regional Laboratories for analytical work in relation to the measurement of atmospheric pollution. The amount of analytical work would not be sufficient to justify laboratories specially for the purpose. Dr. Parker suggested that consideration might well be given by the Local Authorities concerned to the possibilities of some local co-operative arrangement. The County Authorities may be able to assist.

He sympathized with much of what had been said by Councillor Mrs. M. Martin. Every effort was being made to assist manufacturers in improving the design and construction of domestic appliances, with the object of removing faults of the kind to which reference had been made. It was important that the appliances should be really attractive in appearance, easy and convenient in operation, easy to keep clean, and not too costly. It was recognized that there should be better arrangements than in the past for giving instruction on the correct method of installing the appliances and on their operation to achieve the best results. Much had already been done in this direction. Special courses were arranged by the Women's Advisory Council on Solid Fuel; and several members of the staff of the Fuel Research Station, including himself, had given a number of lectures arranged by this Council. The Coal Utilization Joint Council were also

setting up a special centre for training a large number of individuals, who could then train others, including housewives, throughout the country.

Though he had found defects of various kinds in a number of modern appliances, including sharp corners to oven doors, handles that became too hot to hold, and firebars that became jammed or warped within a few weeks, he had not heard any complaints about the size of the front opening in relation to the size of shovel provided. He was inclined to ask what was the size of the shovel in this particular case?

In conclusion, Dr. Parker expressed his thanks for the way in which his address had been received and for the useful points brought up by the contributors to the discussion.

THE CASE AGAINST SMOKE: AN OUTSIDE VIEW

by

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" Sixty Million Pounds Damage " should be the title of this paper; for that is a conservative estimate of making good the ravages of smoke on our buildings over the last twenty-five years.

The case against smoke is self-evident, when we think about it, because it does so much evil to us. We pour smoke out upon ourselves actually at the rate of two and a half million tons each year, or 6,849 tons each day, or 285 tons each hour, or almost 5 tons a minute. Almost half of it comes from chimney pots.

Smoke is an insidious evil for its harm is cumulative and is only partially sensed in our dingy streets and our depressed feelings. That is why humour has become essentially a part of national life. As long ago as 1853 John Leech cheered up his contemporaries with a cartoon on this very subject. The scene is Westminster Bridge: time, two on a foggy morning. A reduced tradesman is sideling up to a scared little man in a tall hat returning home and holds out a razor to him with the question: " Did you want to buy a good razor? "

In this case against smoke it is the chimneys that are guilty: but who is responsible for the action of the chimneys?

When one individual acts offensively against the public interest there is generally a champion to take up the public's cause. When Mr. Whistler painted his nocturne " The Falling Rocket," Mr. Ruskin was so insensed by the picture that he called it " a pot of paint flung in the public's face." Only a farthing's damages was involved here.

The case becomes involved because we the public are flinging pots of soot into our own faces and the National Smoke Abatement Society has had to come forward as our champion to defend us against ourselves. Who will provide the £500,000 a year needed? If only we could rid ourselves of the domestic chimney smoke we should have gone a long way to mitigate the evil. Carlyle said of us that we " are in general, a frank, jolly, well-living, kindly people, they want little more with you than now and then a piece of recreating conversation." Yes! and that recreating conversation round a blazing basket of flaming coals;—Penates and Lares—Radiation is essential to the human body whether from flaming coals or the sun. But in Britain where we have so little sunlight in the winter, the open fire takes the place of it, whereas in countries in which the sun shines brightly in the depths of winter closed stoves are all that is necessary.

The consequences of burning raw bituminous coal in open grates are dire: because of the inefficient combustion of the fuel, masses of fine solid carbon impregnated with tar, escape into the air along with sulphurous gases and minute particles of ash. We are told on the highest scientific authority that these fine particles of soot and ash

are responsible for most of the evil effects associated with atmospheric pollution. " They penetrate the respiratory passages and deposit in the lungs, they promote fog by acting as condensation nuclei for moisture, they scatter and absorb sunlight and they adhere firmly to any surfaces they encounter." Here, surely, in these four items alone we have an indictment against smoke without making a decalogue of them which we easily could do.

It is difficult to tell the extent of the pestilential effect of smoke on our health until comes the evidence of respiratory disease caused by continually breathing the pollution of the atmosphere which ends often in toxaemia and heart failure. The Chief Medical Officer of the Ministry of Health, in his 1926 report said that " It requires a robust constitution and strong lungs to flourish in a polluted atmosphere." " The effects on the human body cannot be traced so graphically as they can in vegetable life, but there is no doubt that dirt and soot inhaled into the lungs inhibit their action and reduce the vigour of the body and debilitate its constitution." With this statement in mind I turned to page 10 in *Guilty Chimneys* where at a glance is laid out pictorially the devastating effects of varying quantities of soot on the growth of plants and soil bacteria in an industrial city that I strongly suspect to be Leeds. With these comparative figures I made a graphical chart by plotting the figures for the growth promoting bacteria in soil against the soot fall in tons per square mile in different parts of the city ranging from the outskirts to the industrial zone. It was astonishing to see how rapidly the growth-promoting bacteria were incapacitated as indicated by a steep drop in the curve between the outskirts of the city through the suburbs to the inner suburb. Over this range the soot burden was from 42 to 114 tons per square mile. From this point, although the soot increased steadily from 114 to 539 tons per square mile, the curve flattened out sharply and became almost linear and horizontal. It would seem from this inspection that the major damage is done to the bacteria by blanketing the soil with soot up to a concentration of 100 tons per square mile. Next comparative charts were prepared from the figures given for the growth of lettuces by weighing them from time to time, also the heights attained by aucuba (Japanese laurel). These respective figures were plotted against the weight of soot deposited over these several crops. The general form of the curves was the same, as might be expected, except that the steeper parts of the curves were extended farther. Whereas the growth promoting bacteria were checked suddenly after 100 tons per square mile of soot had been deposited, the lettuces fell in weight sharply at 243 tons of soot deposit, the curve being almost horizontal beyond this. No doubt the difference in slope of the curves between 114 tons and 243 tons of soot per square mile would be due to diminishing intensity of light caused by the soot suspension in the air. The stature of the aucuba suffered a comparable loss. Over the whole range of soot burdens the growth promoting bacteria lost 87 per cent. of its power, while the lettuces lost 218 per cent. of their weight and the aucuba 430 per cent. of their height.

In so far as animals and plants depend vitally on the air it might be reasonable to surmise that in some way human beings suffer loss of vitality in similar proportions to the plants nurtured in polluted air. This idea is unsettling to say the least, to think that because of the excreta of our fires and furnaces the majority of us are never in the best possible health. It may be significant that when a person gets away from England into Switzerland or America he finds that exhilaration of being wide awake and " rearing to go " so rarely experienced in these smoke ridden Islands.

So far the evidence in this case against smoke has dealt only with our everyday experiences. In our large industrial cities usually in the worst seasons of the year come heavy concentrations of smoke and tar that we call fogs. The

whole world has heard of our famous London fogs. Native Americans believe that England lies under fog most of the year. They will say to Englishmen who reside there when a pleasant white mist descends upon them such as is experienced on Snowdon: "You must feel very much as though you were home?" You may humour them by agreeing when a more correct answer would be, "You would never know." Especially if you had struggled on foot at 3 o'clock on a November night from Kensington High Street to Chelsea, arriving after two hours with face and hands literally streaming black and feeling really damaged goods, which you are. This, however, is only the superficial side of the matter with no deaths reported. When a serious statistical examination is made of the dense fog that enveloped nearly the whole country for days in late November, 1948, and of its consequences to health alone, one is left shaken.

W. P. D. Logan, M.D., writing in *The Lancet* about this recent dense fog says that "The sharp rise in deaths registered during the week of fog stands out clearly, 20 to 30 per cent. more deaths being recorded in that week than of the four previous weeks." He goes on to say: "As was expected, much of the increased mortality was due to respiratory infection. Registered deaths due to bronchitis and to pneumonia more than doubled during the last week, deaths from most other causes being little if any higher than in the previous four weeks." And then comes this uncomfortable statement: "There was, however, some increase in deaths from myocardial degeneration and *cancer*." I would advise my friends to study these statements under the heading of "Fog and Mortality" by the Assistant Medical Statistician, General Register Office, W.C.2 and to be found recorded in *Smokeless Air* No. 69, 1949.

Surely I have strengthened my case against smoke now that I can prove its lethal powers.

But a lot will have to be done in the way of educating the public to break down their indifference to the evil. Only recently I opened the Halifax *Courier and Guardian* of August 8th, and under the caption "To-day's picture," found a view of Halifax taken from Godley Cutting which the paper describes as "the smoky panorama." It describes the varied reactions of people looking down on Halifax for the first time, how they "shuddered with horror at the scene unfolded before them." "They forget," comments the paper in extenuation, "that if there were no mills, no foundries, no gas and electricity works, they could not have the amenities and comforts they enjoy." Here you have the equation; but to make bad worse an incident is described of how a visitor from a Scottish town comes to see Halifax from this point and exclaims "I wish I could take two-hundred of those mill chimneys to my home town." And to round off the picture the *Courier and Guardian* concludes: "Dirty and smoky the outlook may be but the view certainly reflects something of the vitality of the people." Yes! they survive. But the soot particles continue to enter the lung cells where they become permanently deposited. The air cells are eventually robbed of their elasticity and this continued abuse being cumulative can result in total incapacity or death, it is only a question of time and the vitality of the individual.

In contrast to smoky Halifax my mind often dwells on Allentown, Pennsylvania, U.S.A. Here is a town of almost the same size, where civic pride makes it a joy to walk its streets. The town rises steeply from the Lehigh Valley with the railway running through it and there is the usual gas works, which makes water-gas smokelessly and silk mills with gardens about them and flowers in window boxes—the electricity comes 500 miles from Niagara. The wide streets rise sharply to a plateau and continue very straight giving long vistas. The buildings are constructed mostly of a native limestone with a mica schist inclusion which glitters in the sunshine. White paint adorns the woodwork which gives an air of

lightness and gaiety to the surroundings and the only noticeable smoke apart from the railway is cigar smoke whose aroma gives a sense of holiday to the spirit. In the midst of the town and dominating it is the inevitable twenty-two storey building, a great tower gathering everything about it and often with its ornate head in the clouds. At its base eerie puffs of wind sweep you on or oppose your progress as only can be experienced around such giants. To add to this gaiety of scene, lamp standards carrying their graceful white globes have bowls of flowers about them in summer and evergreens in winter. I could not keep away from this town, it called me to it for twenty years and I enjoyed it at any time of day and night, winter and summer. To me it was the town of towns.

What is the secret of this urban youthfulness? The major secret is the freedom from smoke. The town lies not many miles from Wilkes-Barre and Scranton, the heart of the anthracite coal regions, and what fires it uses are of smokeless anthracite. Furthermore, near its centre, a great white chimney with never a cloud of smoke above it, indicates the great central heating plant for the town. From its boilers, pipes radiate to all parts of this cheerful place, under the roads to houses and factories, and you are only conscious of them by whisps of steam from a grate in the street where there may be an occasional leak. Oddly, one does not miss the open grate in the homes and there is always a sense of adequate warmth. The psychological effect of this clean town bathed in sunlight is so immense that your spirit reacts to it with unbounded optimism. If only such beauty of clean buildings and light to show them off could be brought to most of our industrial towns! In Leeds now in City Square the huge Queens Hotel has been scrubbed of its grime, but how it throws up the multi-begrimed buildings round the square. A year ago a large cinema in the square was likewise cleaned to a whiteness unthinkable, but even now it is turning grey and under eaves and cornices long black finger-like streaks of soot are following their characteristic course. I have said nothing so far as to the financial extent of the ravages of soot because the monetary values are so changeable but in 1915 the measurable damage done to Manchester and Salford by smoke amounted to £1,000,000 a year, entirely apart from the immeasurable damage to health. More recent estimates of damage would not probably be much different from this figure. Measurements of daylight in Manchester made over a period of eight years showed an average drop of 30 per cent. at the City centre below the light in the country-side seven miles away; whilst in Glasgow the loss of light both in summer and winter reached almost 70 per cent. during 1939-40.

"Sunshine is an important bio-dynamic agent," says Dr. J. E. W. Wallin of the University of Pittsburg. He means that it makes us feel good. Smoke lessens the radiation from the sun, thus increases humidity, mists, fogs, and alters the electrical pressure about our bodies. Soot may be a carrier of obnoxious products of human fatigue, which, through it, contact eyes, nose, throat and lungs and reach the gastro-intestinal tracks which all combine to lower our potential reserves and produce eventually premature decay of our bodies.

So far I have not distinguished between the different kinds of smoke. Some is more pernicious than others. As a rule, domestic smoke has a greater adhesive power than factory smoke because of a greater tar content; the effect of domestic smoke is proportionately greater in winter, and it may be confidently stated that domestic smoke is more pernicious in its attack upon human and vegetable life. Thus the combined effect of the two kinds of smoke in large centres of population is very disastrous.

What about raiment? The family laundry bills are of course much larger in the big industrial towns. The complaint against smoke—railway, factory, mill and house—is the same in all parts

of the world. In Bethlehem, Pennsylvania, many a time have I heard the women complaining when the wind set from the south against the bath of smoke from its three railroads, the Bethlehem steel plant, and the Bethlehem foundry. When the wind blew from the north the Irish and Hungarian women grumbled and cleaned, and when the wind was in the east the Pennsylvanian-Dutch women complained in their strange tongue; but it all amounted to the same thing, they didn't like smoke.

There are three big laundries in the town, two called steam and one electric, and all doing well.

Chartered Accountants have worked out the difference of cost for us as between Harrogate and Manchester and tell us: "Taking into account the 36,742 families living in houses of eleven shillings a week and upwards at the same rate, the total cost of washing in excess of the Harrogate standard is £242,705." Also, the extra cost of the Manchester wash in materials and fuel was sevenpence halfpenny per week for each household, or about an eighth of the cost of the National Health Service per person per annum. It is beyond the scope of this paper to consider how we can rid ourselves of this pestilence. Certainly something is being done, for the figures of the annual sootfall in many large industrial areas is less now than in 1890. It is definitely less in Leeds.

One of our difficulties from the domestic angle is that we have inherited old-fashioned fireplaces. When I went to live in London the date on my kitchen range was 1851—as illustrated in Mrs. Beeton's cookery book—and it is still in use along with thousands of others. Some friends of mine went to live in Westminster and furnished their house in period style. The existing grate was removed and replaced by a basket fire with hobs to be in keeping with the period and the general efficiency of the antique grate was even lower than the one it replaced! Another friend who was proud of a grate with highly polished steel bars, admitted that he could get more heat into the room when burning semi-coke but the concentrated heat was eroding his steel bars. Of course, to my friends it was unthinkable to use either closed stoves, or gas or electricity. There was central heating in one of the houses but only in the passages.

A learned professor, whose writings on the smoke nuisance are still respected, while fulminating against the evils of smoke would be having his dinner cooked on a wasteful bituminous coal range in his kitchen while he warmed his hands at a bituminous coal fire in his study and his house was wreathed in black smoke from his chimneys.

And yet is it to be wondered at? Bituminous raw coal is really all we are offered readily for our fires and if we burn it in closed-in stoves with greater efficiency than in open grates we create vicious black smoke. Only by completely abandoning raw bituminous coal for domestic use can we hope to mitigate the smoke nuisance and avoid the losses and waste by so doing.

In conclusion I can find nothing more apt to say than quote the Rt. Hon. E. Shinwell, M.P., in the House of Commons, 16th March, 1945: "For many years it has been my view and I even met with a certain amount of opposition among people in mining areas who are so accustomed to burning coal in its raw state, that if I had the power myself—I mean real power, the sort of dictatorial power one would like to assume on certain occasions in order to get something done—I would have prevented the burning of coal in its raw state in this country. Some people like it. I think it is an abomination, and, in the long run, from the standpoint of health and of fuel conservation, it would be one of the finest reforms in which this country has ever engaged if we could prevent the burning of coal in the raw state."

Discussion on Mr. Sinkinson's Paper

Alderman J. S. Tennant (Harrogate), sessional Chairman, in introducing Mr. Sinkinson, said that over a hundred years ago in a Health Act, smoke abatement was named, and again in Disraeli's famous Public Health Act of 1875, but it seemed to have become a Cinderella. It was therefore their duty to show the great harm done by smoke and to continue to press for its reduction and ultimate abolition. Domestic smoke was given as Public Enemy No. 1. They had been promised cheaper gas and electricity under nationalization, but the reverse was the case. He hoped some of the new appointments at high salaries would be reduced and economies effected, and that smokeless heating would be brought within the reach of all.

A. C. Hazel (Coalite and Chemical Products Ltd.) said he thought that many prominent people at the Conference, when calling the open fire "public enemy No. 1," really meant that smoke was "public enemy No. 1."

An open fire in which smokeless fuel was used might be justifiably regarded as "public benefactor No. 1," because of the beneficial effect a cheerful, ever-changing, ever-flickering glow had on the minds and bodies of all those who enjoyed its healthy warming rays.

Mr. Hazel thought it desirable to make this point perfectly clear namely that the open fire, *providing* smokeless fuel was used, was of the greatest possible benefit to the nation, and should not be condemned out of hand, as indeed it had been at this Conference.

He went on to emphasize, and to endorse the remarks made by others, about the advantages of the new domestic appliances now becoming available in greater quantities, but he also said that these appliances did not automatically burn coal smokelessly, though efforts were being made in that direction.

There was only one way in which to eliminate smoke in the domestic sphere, and that was to make coal smokeless.

Mr. Hazel said that the object of the Conference as far as the domestic market was concerned, was surely to abolish smoke emanating from *existing* domestic appliances, and he said that he thought one of the best answers he had seen to this question was contained in a paper by Sir Claude D. Gibb in the current issue of *Smokeless Air*, copies of which were on the Conference Bookstall. Sir Claude D. Gibb in this paper asked "What fuel is to be used in the millions of homes already existing and only possessing open coal fires ?" Sir Claude D. Gibb's answer, with which Mr. Hazel heartily agreed, was "The answer is semi-coke (obviously that produced by low temperature carbonization), which will light as readily as household coal and will burn with a smokeless fire radiating a greater proportion of heat."

Delwyn G. Davies (Water Engineer and Manager, Harrogate) considered the effect of atmospheric pollution on water supply a problem that was possibly not well known. Intense fogs, such as those which covered Britain in November, 1948, deposited their filth on service reservoirs and lay on the water as thick black scum. Although this atmospheric pollution carried with it only small proportions of phenols, the reaction with the sterilization processes of the water was so strong as to produce noxious tastes making the water completely unpalatable. As little as one part of phenols in 20,000 million parts of water was sufficient to cause this reaction with chlorine and produce the unpleasant chlor-phenols. Such happened in Harrogate in November, 1948, when the great smoke belt from the industrial cities of Yorkshire drifted to Harrogate. The sterilization method had to be altered and the reservoir was temporarily put out of action. In a similar manner, the atmospheric pollution from the industrial cities was deposited on upland

gathering areas and eventually the phenols were washed in by the rain to produce a similar but less marked reaction. If our cities were cleaner, then the efficiency of most water supply processes could be raised. An interesting case occurred in Manchester a few years ago when one of the very large service reservoirs turned bright red and unfit for human consumption. The cause was said to be the accumulated deposition of sulphates from the atmosphere which produced sulphate bacteria. It was difficult to assess accurately the potential increases in water demand due to atmospheric pollution but it was not unlikely that these extra needs required a capital expenditure on waterworks as much as £200 millions.

His Worship the Mayor of Bury (Alderman W. K. Heaton) said the Government should give more assistance and less "lip service" to local authorities in the fight to prevent smoke pollution. He stressed the equal need of dealing with both industrial and domestic smoke emission and commented upon the reluctance of the Ministry of Health to confirm the adoption of byelaws by local authorities for dealing with industrial smoke. Bury had applied to the Ministry on three occasions for permission to adopt such byelaws and on each occasion had been referred to the Ministry of Fuel and Power for consultation. Upon the last occasion the Ministry of Fuel and Power had agreed to support the Council in their application, but despite this recommendation the Ministry of Health had again deferred the granting of byelaws. It appeared there was an entire lack of co-operation between the two Ministries. Local Authorities instigating proceedings in respect of smoke emissions, under the Public Health Act, 1936, had to satisfy the magistrates a nuisance was caused on each occasion, whereas an offence was committed whenever the byelaw was broken. Bury had been denied these powers, although the Ministry of Fuel and Power had said they should be granted.

Sydney N. Duguid (Member) said that the ultimate success of the smoke abatement movement depended largely upon the enthusiasm of its adherents. He hoped that every individual present would go back home and preach smoke abatement as a crusade. It was useless to expect vigorous action from the Ministries concerned until public opinion was so strong that it could not be resisted.

Increased powers to deal with the nuisance were, no doubt, desirable, but the powers already possessed were not being used to anything like the full extent and this was deplorable. If local authorities had not got "the whole armour of Saul" they had at least something much superior to the "Sling and stone of David" and they ought to employ the weapons they already possess to the full. It was not necessary to wait anything like 20 to 30 years for the elimination of industrial smoke if the existing powers were exercised.

The abolition of domestic smoke was a far more difficult problem as it depended somewhat upon income. The ordinary householder could not afford to use electricity extensively for heating purposes and the fact that coke cost more than coal militated against its use. Large increases in supplies of coke and drastic reduction in the price of it, would put more life into the drive for smoke abatement in this field.

Councillor C. A. Jaine (Stockport) said with what speed, and energy, and ingenuity, the smoke was abated from our merchantmen in the submarine crises during the war. He could not understand why, if this Government were serious in their endeavour to abate smoke, they did not pass legislation to compel the fitting of this very useful invention on all Lancashire type boilers. He also observed that they were not making the public smoke conscious, and added that they must educate the public and point out to them the dangers to their health. If they could do that the Government would soon act.

W. Beaumont (Chief Sanitary Inspector, Coventry) referred to the ravages of smoke in connection with the health of the nation, buildings and agriculture and he thought that the time was now approaching when serious consideration should be given to the question of making the scheme " Prior Approval " of boiler installations obligatory.

Unless this scheme was put into operation throughout the country there was lack of uniformity and whilst in one district the local authority might be energetic and smoke conscious, smoke nuisances might well be tolerated by the local authority of an adjoining district.

Results of the operation of the scheme in Coventry had been very encouraging and unless compulsory powers were in operation in all districts, whilst one was taking action to abate smoke nuisances from a particular source, it was possible that at the same time new sources of atmospheric pollution were being created.

Dr. C. F. White (City of London) said that a previous speaker had seemed to suggest that there was lack of enthusiasm in regard to smoke abatement. He contended that there was no lack of enthusiasm amongst the delegates to this Conference, but he submitted that enthusiasm, untempered by knowledge and experience, might do more harm than good, in the present difficult circumstances. In illustration he related a story of a pillion rider on a motor-cycle, who reversed all his clothing in order to keep out the cold wind. On a sharp corner he slipped off and died, not from the fall, but because over-enthusiastic helpers insisted on screwing his head round to what appeared to be its proper position !

F. J. Redstone (Chief Sanitary Inspector, Bristol) said that a great deal had been heard from various speakers about the enthusiasm needed to bring about a real improvement in the condition of the atmosphere throughout the country. As Chairman of the Society's Publicity Committee, he felt it was necessary to point out that a great deal of enthusiasm already existed although this was not as general as it might be. Looking back just a few years one could remember Smoke Abatement Conferences attended by about 100 delegates but the fact that there were 450 delegates present at this Conference, proved that interest was increasing to a remarkable extent ; it was a grand thing that this should be so. Unfortunately, however, the financial resources of the Society were not keeping pace with the demand for action and in many ways activity was frustrated by lack of finance. Just imagine, said the speaker, the work the Society was expected to do on an income of £3,000 per year from the whole country. This amount was obviously ludicrous if they were to attain the objects desired. He called upon the Ministry of Health to assist the work of the Society by clearly indicating to every local authority, whether they have a clean atmosphere or not, that the work of the Society was of real value and should be supported. It was essential that clean air advocates should never become peeved because improved methods and schemes are not adopted quickly but rather to work away with unrelinquished enthusiasm in an effort to convince everyone concerned that although there are many difficulties to be surmounted the results will be very worthwhile.

Eric Sinkinson, replying to the discussion, said that the evils of smoke would never be abated in Great Britain until raw bituminous coal was replaced as a fuel.

Science, happily, was making rapid strides towards this end, by a wider distribution of gaseous fuels for heating appliances ; also, by a greater adoption of electric energy for motive power which was becoming a possibility ; and, not least, the increasing use of carbonized coal at a reasonable price when compared with the price of raw coal would assist this end.

Resolutions

The following Resolutions were adopted by the Conference during the course of its discussions :

1. Approved Appliances in New Houses.

THAT this Conference welcomes the action of the Minister of Health and the Secretary of State for Scotland in requiring Local Authorities to specify only the types of grates or stoves included in the list of approved appliances for installation in houses built under their housing schemes, and expresses the hope that they will extend this requirement to houses built under licence by private enterprise.

2. Use of Smokeless Fuels in New Houses.

THAT this Conference learns with regret that in many instances bituminous coal is being burnt in grates suitable for smokeless fuel in houses on Local Authority Estates, which is in some cases exceptionally offensive from its being emitted at a low level from prefabricated bungalows, and asks all Local Authorities to encourage the use of smokeless fuel in these grates.

Councillor A. Mead, C.C. (Kirkby-in-Ashfield) said that with the Chairman's permission he would like to call the attention of Conference to an anomaly, which in his opinion was of considerable importance to the Society.

He stated that, as a member of an Urban District Council, his Authority was empowered to pay him subsistence and financial loss allowances for the purpose of attending this Annual Conference. But if he—or any of those present as representatives of a similar Authority—should be successful in being elected to the Executive Council of the Society, their Authorities could not reimburse to them the reasonable expenses incurred in attending the meetings of the Executive.

But, providing they could answer in the affirmative the question " Would the knowledge acquired by the attendance of an Officer at the meeting be of value to the Council in the discharge of their duties ? " they could send one of their Officers to a Conference and pay his expenses without any danger of having to cross swords with the District Auditor.

He asked Conference not to think that he was unappreciative of the work done by Technical Officers in their efforts to abate smoke nuisances, but he was sure that elected members of local authorities could also make a valuable contribution to the efforts of the Society in achieving its main object. Particularly would this apply if the member happened to live in a district where the public suffered badly from smoke pollution.

His own Council had asked the Minister of Health to approve payment of the expenses of one of their members in attending meetings of the Executive, but without success. They had also asked the Urban District Councils Association to take up the question with the Minister, but he understood that they were not likely to get much assistance from this source. He added that his Member of Parliament had offered to raise the matter in the House, but he himself thought that this was the place and the time where some united action should be taken to get the Minister to see that this was no personal or political question. Our request, he said, should be, and was, based solely on the interests of the health and happiness of the people who, by the nature of their employment—or the employment of those upon whom they depended—were forced to live in an environment of which at least 50 per cent. of their fellow-citizens throughout

the country had no conception.

He asked the Chairman's permission to move " That this Annual Conference of the National Smoke Abatement Society considers that members of local authorities who, on nomination of their own Councils, are elected to serve on the Executive Council of the Society, should be entitled to allowances under Part VI of the Local Government Act, 1948, and that the Minister of Health be asked to extend the expression 'approved duty' under Section 115 of the Act, to include members of a body, to which that part of the Act applies, when attending meetings of the Executive Council of the National Smoke Abatement Society."

[It was ruled by the Chairman that as the resolution had not been submitted by the required date for the preliminary consideration of the Executive Council, it could not be moved. He asked the General Secretary to reply to Councillor Mead's statement.

Arnold Marsh (General Secretary) replying to Councillor Mead said that the Officers and Executive Council had given close consideration to the question of the payment of the expenses of members of local authorities elected to the Executive Council. In addition to the case of Kirkby-in-Ashfield, referred to by Councillor Mead, exactly the same problem had arisen in respect of a representative elected from the South-West Division. Informal discussions had been held with Ministry officials, who, though sympathetic, were bound to refer to the legal difficulties. The Society's Chairman, as a practising Barrister-at-Law, had agreed to examine the legal position more closely, but, as the Conference would appreciate, his illness had meant the deferment of this inquiry. Councillor Mead could rest assured that the Society was most anxious to have on its Council members of the smaller local authorities that were subject to such restrictions, and would continue to search for a solution of the problem.

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PRESIDENTIAL ADDRESS

A Survey of Domestic Smoke Abatement

by

LORD SIMON OF WYTHENSHAWE

IT is an honour and a pleasure to be elected as President of the National Smoke Abatement Society in my seventieth year. I am to-day going to attempt to outline the history of smoke abatement over the last fifty years and hope you will forgive me if I begin by setting out my qualifications for this task.

I began a business career in Manchester in 1901, living in the south of the city, and almost every winter's day for a quarter of a century as I drove to my office I met the too familiar pall of smoke just about at the University.

So the first society I ever joined was the well-known Manchester and Salford Sanitary Association under the chairmanship of that great Manchester citizen, T. C. Horsfall; one of its chief activities was to work for the cleaning up of the atmosphere of Manchester. Later I took an active part in the Manchester Smoke Abatement League and then became secretary of a national Smoke Abatement League which had its headquarters in Manchester and was one of the predecessors of the present Society. For twelve years I was a member of the Manchester Public Health Committee which was fairly energetic in dealing with factory chimneys; some of the members insisted that it was possible to trace the boundary between Manchester and Salford by following the line of smoky chimneys, all of which were in Salford!

After World War I, I became Chairman of a sub-committee of the Manchester Public Health Committee known as the Atmospheric Pollution Board, which undertook what I believe to have been the first serious scientific investigation into the efficiency and the smoke-producing qualities of our old enemy—the open coal fire. It also undertook what I may perhaps call the classical investigation into the extra cost of the household wash in Manchester as compared with Harrogate, and provided evidence (verified by a firm of chartered accountants) that the extra cost, due to the smoke of the Manchester atmosphere, of this one item alone was no less than a quarter of a million pounds per annum. I should like to take this opportunity of paying a tribute to the work done in the smoke abatement field in those days by our old friend Mr. Will Melland, to whose initiative this particular inquiry was largely due.

Next came the Committee on Smoke

Abatement appointed by the Minister of Health under the chairmanship of Lord Newton. Its report in 1920 was the first official recognition of the importance of domestic smoke. I was a member of that committee and at that time wrote my first book with the ambitious title " The Smokeless City." Then for twenty years I gave up direct work on smoke abatement; though I was closely concerned with housing, and took an active, but I am sorry to say, quite ineffective interest in trying to secure the installation of smokeless appliances in the new houses.

In 1945 I became a member of the Egerton Committee on Heating and Ventilation appointed by the Department of Scientific and Industrial Research, and then Chairman of the Committee on Domestic Fuel Policy appointed by the Ministry of Fuel and Power. I apologize for these lengthy personal details; the sole object is to show that I happen to have perhaps as long and wide experience of smoke abatement problems as anybody in the country.

Looking back over the history of smoke abatement it divides itself naturally into three stages:

Stage I goes back to the first protests against the smoke nuisance and ends with World War I.

Stage II covers the inter-war period.

Stage III begins with the end of World War II.

Stage I

The early history of smoke abatement is marked by innumerable angry protests against the smoke nuisance and a good deal of punitive legislation. The earliest such action of which I know was in 1307, when circuit justices in London were commissioned " to enquire of all such who burn sea coal in the city, or parts adjoining, and to punish them for the first offence with great fines and ransomes, and, upon the second offence, to demolish their furnaces."

So far as we know this was quite ineffective and the same kind of thing went on equally ineffectively over the centuries. About the beginning of this century local authorities began to prosecute manufacturers for the emission of black smoke. Where it was done on a systematic basis it had some substantial success. But it is roughly true to say that action was still confined to prosecution and that neither the Government nor local authorities had begun to use scientific methods and to study the problems of efficient and smokeless combustion. And it is undoubtedly true that neither the Government nor local authorities had begun to give any attention to the domestic smoke problem. The old-fashioned open coal grate and smoke-producing kitchen range were still being generally introduced with no protest whatever.

The effective smoke abatement movement, so far as domestic smoke is concerned, dates from about the end of World War I. It was only then that the importance of domestic smoke began to be realized and that research and development began to be undertaken in that field both by private enterprise and the Government.

Stage II

The story of factory smoke during Stage II is one which covers large extensions in the use of electricity; the considerably increased use of gas; great improvements in the structure of boiler plants for efficiency and smokelessness; and steadily increasing co-operation between local authorities and manufacturers in making combustion more smokeless by the training of stokers, and in other ways. This has been and is a continuing process; great progress has been and is being made towards a really satisfactory state of affairs. The story of the domestic smoke problem is a very different and a much more difficult one and I propose, therefore, to confine my address today almost entirely to the domestic problem.

The landmark in the first years of Stage II was, of course, the publication of the Newton Committee's report in 1920; the first public and authoritative report which pointed out the immense importance of the damage done by domestic smoke. A good deal of new

evidence was available to the Newton Committee mainly based on the scientific work carried out in the years just before 1920. In particular, there had been many investigations into the damage done by smoke : the damage to the health and spirits and vitality of human beings through poisoning by acid and tar and through the cutting off of sunlight ; the damage to trees and plants and crops ; the damage to buildings. New evidence was also available as to the preponderating part played by domestic smoke in causing this damage.

Research into fuel efficiency and smoke emission had begun at the Fuel Research Station ; the gas industry had developed efficient domestic appliances of different kinds ; the electricity industry was beginning to follow suit. Other researches were going on ; for instance, it was a startling innovation for the Manchester City Council to make an annual grant up to £500 to its Air Pollution Advisory Board for purposes of research. The work was carried out in the Manchester College of Technology with the help of leading scientists from the University and was, I think, the first serious research into the efficiency and smoke-producing qualities of the open coal fire. It is interesting that the work was under the direction of Dr. Sinnatt, who afterwards became the head of the Government Fuel Research Station.

The Newton Committee first met in March, 1920. So impressed was it with the urgency of using better methods of domestic heating in the large number of new working-class houses which it was hoped were to be rapidly built that it actually produced an interim report in three months, pointing out that the open coal fire and the old-fashioned kitchen range were " inefficient, wasteful of fuel and labour, and productive of smoke." Better appliances and methods were available though much research was still required. It recommended that :

1. The Government should decline to sanction any housing schemes unless specific provision was made in the plans for the adoption of smokeless methods for supplying the required heat.

2. The Government should encourage the co-ordination and extension of research into domestic heating problems.

The Committee was wise and right. It need not have been in such a hurry. Lord Newton wrote in 1922 : " The very Ministry which was established to protect the health of the people has hitherto completely ignored the damage, waste and discomfort caused by domestic smoke." And twenty years later that same Ministry had still taken no action whatever under either of the recommendations of the Newton report.

The main report, published a year later, repeats the same recommendations and ends with the words : " The initiative rests, of course, with H.M. Government, and we trust that the necessary action, which has been long overdue, will be taken at the earliest possible moment."

The Newton report was an admirable document. It is a lamentable fact that so far as action by the Government was concerned it might just as well never have been written.

Stage III

The beginning of the third and final stage in the history of smoke abatement is marked by the creation of the Ministry of Fuel and Power in 1942. Owing to the grave shortage and high price of coal, more efficient consumption had become an urgent national necessity and the Ministry from the beginning meant business. Over one-third of our coal is used in one form or another for domestic purposes, so the Minister in 1945 appointed a strong committee, of which I was Chairman, with the following terms of reference : " To consider and advise on the use of fuels and the provision of heat services in domestic and similar premises, in the interests of the occupants and of the nation, with special regard to the efficient use of fuel resources and to the prevention of atmospheric pollution."

The report was published in 1946 and this is how we summed up the position as regards domestic heating.

" The four million houses built in the

inter-war period are probably larger than houses in other countries for the corresponding income groups, yet the area of the house properly warmed for comfort during the winter is probably smaller than in any other civilized country. . . .

" Our coal is used for domestic heating with a degree of inefficiency which is not, so far as we can ascertain, even approached in any other country in the world. . . .

" Over 80 per cent. of domestic heating is provided by burning bituminous coal mainly in open grates or in kitchen ranges. The open grate has always been the greatest sinner in smoke production . . . .

" To sum up, we are using excessive quantities of coal ; we are providing inadequate heating in our houses ; we are pouring out masses of soot and tar into the atmosphere. . . ."

That is the Committee's verdict on the four million houses built under the control of the Ministry of Health, after it had received the Newton report, and in spite of the continuing efforts of the National Smoke Abatement Society.

Smoke abatement has always been the blind spot of the Ministry of Health ; I am glad to say that at long last there are signs that this is beginning to clear.

We found the position as regards research and development much more encouraging than it was in the days of the Newton report.

The most important developments had been in the gas and electricity industries ; both had developed satisfactory (and of course smokeless) cookers and had sold them on a large scale, and important advances had been made in various other domestic appliances using gas and electricity. In 1938 15 per cent. of the heat used domestically was in the form of gas and electricity. The other 85 per cent. was burnt as solid fuel, and here progress had been painfully slow ; the amount of reasearch had been utterly inadequate.

Turning to the post-war period we found that during the last two or three years there had been great progress, particularly on the part of private enterprise. There were some strong research organizations in existence among individual large firms in the gas and electricity industries, and a few were beginning to appear among manufacturers of solid fuel appliances ; there were also several organizations of growing importance controlled by industries. What was perhaps even more encouraging, we found that at long last the Government was taking an active interest in research and development. During the war nothing had been done except a slight extension of the facilities of the Fuel Research Station, which did useful work on a tiny scale. Now things were different. At the instigation of the Ministry of Works, the D.S.I.R. had appointed a Committee on Heating and Ventilation under the chairmanship of the distinguished scientist Sir Alfred Egerton, whose report produced a mass of basic facts covering nearly all the scientific aspects of heating and ventilation. The Simon report may be regarded as an attempt to indicate how the data given in the Egerton report can best be applied in practice.

The Ministry of Works had also appointed a Scientific Advisory Council which was already at work in many directions, including an ambitious plan for the building of a number of working-class houses for large-scale testing in practice of different systems of heating and ventilation.

The Department of Scientific and Industrial Research was greatly expanding the Fuel Research Station, which had now become strong enough to give us invaluable help.

The Ministry of Fuel and Power had during the war developed a strong Fuel Efficiency Department, which helped us both on scientific and practical problems. And indeed the Ministry spared no pains to give us every possible facility and help.

The Atmospheric Pollution Research Committee under the D.S.I.R., and with the co-operation of over 50 Local Authorities, had published annual reports giving useful facts as to the amount of atmospheric pollution.

In short, we had advantages both as regards the scientific and technical evidence available, and the active interest and support of Government departments, which marked a complete revolution as compared with the experience of the Newton Committee.

The Committee concluded that there were three main lines of development for efficient, convenient, and smokeless domestic heating. The most important is to replace the bituminous coal used for domestic purposes by some smokeless solid fuel—anthracite, or some form of coke or briquette, to be burnt with an efficiency of not less than 40 per cent. The second is to increase the use of gas and electricity from 15 per cent. to, say, 30 per cent. of the total fuel consumed, in about twenty years. The third is to burn bituminous coal with increased efficiency and much less emission of smoke. These three developments depend on action by many different bodies in many different directions.

Two specially urgent developments are a cheap and efficient system of central heating for small houses, and (most important of all) a stove to burn bituminous coal smokelessly, or nearly smokelessly. I venture to predict that both these will be on the market at reasonable prices within the next few years.

District heating may prove to be an important line of advance, but there are serious difficulties. A dozen plants are likely to be at work within the next year or two.

Then the design of the house is most important; there must be expansion of research and development in many directions; unbiased technical information must be made easily available for local authorities, builders, architects and householders.

Our Committee made no less than 41 separate recommendations, and concluded that if these recommendations were reasonably followed it should be possible to secure that the 50 million tons of bituminous coal now burnt with a working efficiency of 20 per cent. should be replaced in 20 years by smokeless solid fuel, or by bituminous coal burnt smokelessly, or by gas, or by electricity, with an average coal economy efficiency of not less than 40 per cent.

This would render possible the following results:

The virtual abolition of domestic smoke.

Less labour and dirt in the house.

And either:

(*a*) Doubling the useful heat in the smaller houses at little or no greater cost to the householder and no increase in the consumption of coal, or

(*b*) An increase of 50 per cent. in the useful heat in the smaller houses with a substantial reduction in cost to the householder and a saving to the nation of perhaps ten million tons of coal per annum.

We pointed out that to achieve these results in twenty years meant an annual increase in the output of all kinds of smokeless solid fuels of one million tons. If the increase averages only 650,000 tons, then thirty years will be needed. Much depends on the vigour of successive Governments and of the National Coal Board. But the encouraging thing is that the Committee felt justified in suggesting that it should be possible to achieve these results in from twenty to thirty years.

Conclusion

That means that after thirty years there should be no more domestic smoke, and it is reasonable to assume that the rapid increase in the use of electricity for factories and the greatly improved combustion of the modern super power stations will mean the end of any serious emission of smoke from factories (though the problem of metallurgical furnaces may remain). So that we may look forward with reasonable confidence to the end of the smoke nuisance as a whole within thirty years.

Why has progress been so slow, especially as regards domestic smoke? And why are we justified in believing that it is likely in future to be so rapid?

There are four main reasons:

1. This country is blessed with large reserves of bituminous coal. This is our *most* important natural resource; it

is also the perfect smoke producer. Up to World War I coal supplies were ample and very cheap, after World War I supplies were still ample but expensive and people began to think seriously of economy. Now coal is much more expensive and we are not producing enough to meet all our needs. The country has been forced to think hard and to act. The Ministry of Fuel was created and has been acting with great vigour, not primarily in order to abate the smoke but to promote economy and efficiency in the consumption of fuel, which by great good fortune comes to much the same thing.

2. Both the main lines of reform: the conversion of bituminous coal into smokeless solid fuel and the burning of bituminous coal smokelessly for different domestic purposes, require much scientific and technical work. The amount of such work has been utterly inadequate in the past; it has greatly expanded in many directions during the last few years. There is every reason to hope that it will shortly be on a really adequate scale.

3. Public Enemy No. 1 in the smoke abatement world has always been and is today the open coal fire. Lord Newton wrote in 1921: "Hitherto all criticisms of our present system have been met by indignant expostulation that the open fire is one of the sources of England's greatness and prosperity and that any attack on it is of the nature of high treason." Everybody hated smoke, everybody loved the open coal fire; the open coal fire won hands down. The Simon report sums up: "The open coal fire is sociable and pleasant; but it involves dirt and drudgery for the housewife; it wastes millions of tons of coal each year; and it is the chief sinner in rendering our cities unfit for human habitation by its smoke."

Scientific and technical brains have for the last few years been tackling the problems of the open coal fire; efficient, and often attractive, alternatives to the old-fashioned grate are already on the market, and beginning to be installed in large numbers. Progress has been slower than the Simon Committee hoped, but it is reasonable to say that in the battle against the old-fashioned open coal fire burning bituminous coal victory is at last in sight.

4. The fourth reason for confidence is that at last the Government is concerning itself actively with fuel economy and smoke abatement. Of the 41 recommendations of the Simon Committee, 27 were directly addressed to the Government: the Ministry of Fuel & Power, the Ministry of Works, the Ministry of Supply, the Ministry of Health. These Ministries have set up a Joint Standing Committee to follow up our recommendations; and having regard to the shortages of supplies, and the difficulties of carrying out quickly a revolution in domestic heating they are doing a good job. It is most encouraging to be able to record that the Ministry of Health in recent months has been fully co-operative and that when, in 1948, the supply position justified it, the Minister immediately made it a firm condition of approval for all new housing projects that the main heating appliances should be selected from the list of appliances tested and approved by the Ministry of Fuel & Power.

In particular, we owe our thanks to the Ministry of Fuel & Power and the Ministry of Works, who are showing an initiative and energy in this field which represents a complete revolution as compared with the past, and to the D.S.I.R., which is rendering essential services on an increasing scale, mainly through the Fuel Research Station.

Finally, the three great national fuel producing corporations (Coal, Gas, Electricity) are of basic importance. On them lies the responsibility for producing each year more gas, more electricity, and above all a steadily and rapidly increasing quantity of smokeless solid fuel.

If my analysis is right, then it is clear what the main work that lies before the National Smoke Abatement Society in future will be: to endeavour to ensure that the Ministry of Fuel & Power and the Ministry of Works carry on their excellent work with their

present zeal and efficiency; to bring constant pressure to bear on the National Coal Board to reach the target of an additional million tons of smokeless solid fuel each year; and to make every effort to ensure that the Ministry of Health maintains its recent active interest in smoke abatement.

And, of course, a great deal of educational work is needed with local authorities, architects, builders and others; such work is likely to be more effective now than ever before because smoke abatement, without losing its idealism, has now become a practical proposition. Much important work lies before the National Smoke Abatement Society. We have now for the first time the necessary knowledge to solve the smoke problem, and the active good will of the Government. But there is still much ignorance and apathy, and success depends on a great deal of educational work. This can only be done by the National Smoke Abatement Society. Its progress in recent years has been gratifying, but I am sorry to say that its resources have not grown in proportion to the extension of its activities. I very much hope that the Society's appeal for funds which is now being launched will meet with a generous response.

What will it mean to our cities when we have finally abolished the smoke nuisance? May I again instance my own city of Manchester? This is my seventieth year as a citizen of Manchester; I have never lived anywhere else nor have I ever wanted to. It is a fine place to live and work in. It has its faults; the worst ones are due to the appalling cloud of smoke which hangs continually over the city during the winter.

Twenty-five years ago Lord Newton and I visited the Ruhr on behalf of the Smoke Abatement Committee and reported: "The most superficial investigation discloses an extraordinary contrast between such great industrial towns as Dusseldorf and Cologne, on the one hand, and any comparable British towns on the other. The former are pleasant and agreeable places of residence, and the best proof of their amenity is that even the richest citizens continue to live within the city boundaries, a practice which has long since been abandoned in British manufacturing towns."

This is, alas, true of Manchester. Indeed, it has long been true. So far back as 1850 the Stipendiary Magistrate said: "I do not live in Manchester now. Nobody does who can in anyway live out of it." During the whole of my life the vast majority of those who could afford it and whose work allowed it have gone to the pleasant surrounding country; most of them have ceased in effect to be citizens of Manchester or to take any interest in it except as a place to work in and to get out of. Today Manchester has a magnificent plan of reconstruction. One specially important part of the plan is the proposed cultural centre, including the University and the Hospital area and some of the main civic buildings: colleges, halls, theatres, and flats and houses in the near neighbourhood to house the professional class and the lovers of the higher things of life. When these buildings are erected, and many of them should be built in the next thirty years, only one thing more is necessary—clean air and sunshine. Then there will, I hope, be a reversal of the flight from the city, and the leading workers in Manchester will insist on living in their beautiful city and in enjoying the fully civilized life of society and cultural interests which only a great city can offer.

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NATIONAL

SMOKE ABATEMENT SOCIETY

Proceedings

of the

Margate Conference

1950

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Guide to Publications

This is one of the many publications of the National Smoke Abatement Society. For a complete list write to the Society for its current "Guide to Publications on Smoke Prevention and Allied Subjects," which contains, in addition to the Society's own titles, particulars of other books, reports and papers, any of which may be purchased from the Society. The list is classified according to subject—the Law, Conference Proceedings, General, Historical, Smoke Prevention Administration, Industrial Smoke, Domestic Heating, Technical and Scientific, and Industrial Pollution.

NATIONAL SMOKE ABATEMENT SOCIETY

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27th to 29th September, 1950

Chandos House, Buckingham Gate, London, S.W.1

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The 17th Annual Conference of the National Smoke Abatement Society

Margate, 27th to 29th September, 1950

SUMMARY OF EVENTS

Wednesday

THE Annual General Meeting of the Society was held in the Winter Gardens, Margate, on Wednesday afternoon, September 27th, with the Chairman of the Executive Council, Mr. Charles Gandy, in the Chair. In opening the meeting the Chairman referred to the disaster, on the previous day, at the Cresswell Colliery, in Nottinghamshire, and moved that, as the Society was so closely concerned with coal and its uses, its sorrow for the victims of this tragic accident, and sympathy with those bereaved, should be expressed. The Conference thereupon stood in silence.

The Presidential Address was then delivered by Dame Vera Laughton Mathews who read also the following telegram to the Conference from the Minister of Fuel and Power:

> " Very much regret my inability to attend your Annual Conference. May I wish you every success, both during the conference and also in all the valuable work which the Society is doing.—*Philip Noel-Baker.*"

A vote of thanks to the President for her Address was moved by the Chairman, and was carried with acclamation. The business meeting then followed.

In the evening the members of the Conference were entertained by invitation of their Worships, the Mayor and Mayoress of Margate, at a Reception in the Winter Gardens.

Thursday

With the President in the Chair, His Worship the Mayor of Margate, Councillor C. B. Hosking, J.P., officially welcomed the Society to Margate and declared the Conference open. A vote of thanks to His Worship was moved by Mr. S. N. Duguid, Deputy Chairman of the Executive Council, and was carried with acclamation.

The President then called on Dr. D. T. A. Townend, to present the first Des Voeux Memorial Lecture, " Towards the Better Use of Coal." The thanks of the Conference to Dr. Townend were moved by Mrs. H. A. Des Voeux, who said that no memorial to her late husband would have made him more proud than these Lectures inaugurated in his name. The vote was seconded by Dr. R. Lessing, Chairman of the Technical Committee of the Society, who referred to his close association with Dr. Des Voeux and the Coal Smoke Abatement Society in the early years of the century. Dr. Townend responded.

In the afternoon session on " Smoke and Health " Alderman Dr. F. E. Tylecote, Emeritus Professor of Medicine, University of Manchester, presided. Papers were presented by Dr. J. G. S. Burnett and Mr. R. E. Waller, and, at the

end of the discussion a vote of thanks to them and to the Chairman was proposed by Dr. W. R. Martine.

During the evening a " Coming of Age " Birthday Party, to celebrate the Society's 21st year, was held by invitation of the President and Executive Council at the St. George's Hotel. Their Worships the Mayor and Mayoress of Margate attended, and during the course of the proceedings short speeches on the Society and its work were given by two twenty-one year old guests, Miss Coralie Dickerson of Margate, and Mr. F. H. Piggott of Acton.

Friday

Dr. Harold Hartley, Past President of the Institution of Gas Engineers, presided over the morning session on " Smoke Prevention as Applied to New Housing." Papers were presented by Mr. Cyril H. Walker, Mr. C. A. C. Turner, Alderman G. H. Goulden, Alderman J. Robinson, and Mr. F. J. Redstone, and, at the conclusion of a full discussion a vote of thanks to the Chairman and the authors was carried.

For the final session on " Railway Smoke," Sir Ernest Smith, Hon. Treasurer, was in the Chair. The papers by Mr. W. O. Skeat and Mr. M. G. Bennett were followed by a discussion, after which Mr. J. J. Matthews, Chairman of the Conference Committee, moved a vote of thanks to them and to the Chairman. He then moved a vote of thanks to all who had contributed to the success of the Conference, and mentioned especially the Mayor and Council of Margate for the excellent facilities that had been provided, including the use of the Winter Gardens, and their hospitality in arranging the Reception. Mr. Matthews referred also to the considerable help that had been most willingly given by Mr. J. D. Green, Manager of the Winter Gardens, and Mr. G. E. Johnson, Publicity Manager. He continued by referring to the arrangements that had been made for one of the British Railways Instructional Train units to be stationed at Margate during the period of the conference, and for the visits that had been made to it by parties of delegates, and included in his thanks the Society's appreciation to British Railways, to Mr. Bennett, and to the Instructional Staff on the train, for what had been a most interesting and instructive feature of the conference.

The vote of thanks was carried with applause and marked appreciation.

Mr. Harry Priestley, Chief Sanitary Inspector, then conveyed to the Society, on behalf of the Mayor and Corporation of Blackpool, a cordial invitation to hold the 1951 conference in that town.

The Chairman then declared closed the session and the conference.

PRESIDENTIAL ADDRESS

by Dame Vera Laughton Mathews, D.B.E.

It is particularly enjoyable that my task of delivering this presidential address should coincide with the 21st birthday of the Society. Twenty one years is a big slice in a human life-time but in history it is a mere fraction of time. I am sure that if any of us were being examined in history and got within twenty years of the date, we should consider that we had done very creditably—except, of course, for William the Conqueror, 1066.

When a young person comes of an age it means that they have reached maturity, that the worst of teething troubles and adolescence are over—the past is one of growth rather than of achievement and it is the future to which we look for the flowering of promise.

With a Society it is different. Maturity is reached about the ripe age of five years, and at twenty-one a Society is not exactly hoary but it should have a fine record of achievement to its credit as well as a promising future.

Soon there will be a Silver Jubilee to celebrate and I wish we could say that we do not want too many Jubilees after that, that the work the pioneers set out to do will have been accomplished. But I am afraid the full realization of their ideals is still a vision of the future and until that vision becomes a reality, so long will the National Smoke Abatement Society continue with the steady, determined and persistent work which has distinguished it in the past.

As some people are born, so to speak, with a silver spoon in the mouth and have educational and other advantages to help them to a higher stage of development by the time they reach twenty-one years, so Societies vary with the influential and wealthy backing with which they start and which enables some to advance more swiftly.

I think those who remember the small beginnings of this Society, twenty-one years ago with a few devoted enthusiasts who believed whole-heartedly in its aim, may well be proud of its record of work and of what has been already achieved.

Most great reforms have been brought about by a small group of people who care tremendously about a cause and who are not deterred by opposition or sneers. The cranks of one generation are the prophets of the next.

It is not much more than a hundred years ago that we had in this country little children of tender years working in the mines, pulling trucks in the dark, and it took Lord Shaftesbury years, in the face of astonishing opposition, to get this evil abolished.

The British Government is famed for never moving until it is forced to and it is generally the work of private citizens which does eventually produce action.

A few people who really have the faith that can remove mountains, can accomplish more than an enormous mass of lukewarm and halfhearted supporters. I will go further and say I believe opposition and oppression really help a cause—the best way of helping any fanatic is to make a martyr of him. To be taken no notice of is the worst thing that can happen. As Plato said in B.C.400—"The uncriticized life is not worth living."

If you are certain that you are right, then criticism and opposition are to be welcomed. The people to beware of are those who say they agree with you "in principle." If the Government or any individual say they agree with you in principle, it assuredly means that they are going to do nothing whatsoever to help you in practice.

By a slight degree of mental arith-

metic, you will realize that this Society was founded in 1929. Before that the Coal Smoke Abatement Society had been functioning in London since 1899, led by Dr. H. A. Des Voeux and Sir Lawrence Chubb, and it was largely owing to their efforts in the face of a good deal of obstruction and opposition that the Public Health (Smoke Abatement) Act was passed in 1926. That Act gave promise of better control of smoke but the promise has not been fulfilled. Some of the provisions just have not worked.

Then there was also in the North the Smoke Abatement League, formed in Sheffield in 1909 and revived a dozen years later in Manchester under the leadership of Lord Simon of Wythenshawe, the last President of this Society, and Principal Graham of Manchester University. Later the lead was taken by Alderman Will Melland who died in May of this year, after a life spent in the public service, not the least worthwhile of the causes to which he devoted his life being that of purifying the atmosphere, of which in a city like Manchester he well knew the need.

There was also a Scottish Smoke Abatement League working from Glasgow under Mr. W. Brownhill Smith, and these Societies were all merged in 1929 to form one National Smoke Abatement Society and the great step was taken of appointing Mr. Arnold Marsh as Secretary. Through fair weather and foul, he has remained in that post ever since and I think this is an appropriate moment to pay tribute to his devoted service. It is one thing to start out with enthusiasm and quite another to persist year after year with steady determination. As Sir Francis Drake wrote : " In any great enterprise, it is not the beginning but the continuing until it be truly finished which yieldeth the glory."

I know what it is to start a big organization in one back room with no staff. I went through it myself in 1939, when the Admiralty decided to revive the W.R.N.S. without the slightest idea of the enormous organization it was going to develop into.

That small keen Committee with Mr. Will Melland as Chairman and Hon. Treasurer, and Mr. Arnold Marsh as Secretary, started in a small back room in Manchester without even a typist. (And I gather from Mr. Marsh that he is short of staff still !). But in spite of all difficulties they went ahead—Dr. Des Voeux became the first President and Sir Lawrence Chubb Hon. Advisory Secretary, and the first annual conference was held at Buxton in 1929—a private affair held in a hotel.

Some of the pioneers like Dr. Des Voeux and Alderman Melland are no longer with us but they have left a lasting memorial of good work behind —and life being what it is and death the fate of all, that is about as much as any human being can hope for.

But although some of the original members have passed on their way, it is gratifying that several of those who attended the inaugural conference in Buxton in 1929 are at this Conference. Mr. Gandy, our Chairman was there, and Sir Ernest Smith, the present Hon. Treasurer, and Lady Smith ; also, Mr. and Mrs. Duguid and Alderman Perry of Smethwick.

I am very glad that among the outstanding personalities of the early critical years there were a few women. Miss Marion Fitzgerald who is still closely associated with the Society was a Committee member and helped both by speaking and writing. Mrs. Jast was another and I understand that an address she gave was one of the most spirited that has been heard at our Conferences.

In her speech she said :

> " There are cities abroad of size equal to any we know in which gardens and squares and gay flowering plants encourage beauty as the proper setting of industrial work—but we seem in England to regard the worker as specially subject to the curse of exile from Eden . . . . .
>
> " We once complacently and smugly hanged for petty thefts ; we still condemn to the tortures of Sisyphus thousands of women whose sole crime is the desire to

have spotless homes in a region of defiling smoke."

How I wish there were more women members now who could talk about smoke and smoke prevention so vigorously and urgently. I do feel that we must do all we can to bring home to the women of this country the fact that this is a question which concerns them very closely.

I am not proposing in this short address to give a detailed history of the Society, but I think I should mention the first local authority which officially invited the Society to hold its Annual Conference, when a civic welcome was given by the Lord Mayor. This was the city of Leicester in 1930, when the Society was one year old. It marked the beginning of a new epoch because until then apathy and even derision had met the efforts of Dr. Des Voeux and others to impress on local authorities that smoke prevention was their responsibility.

As with many a struggling cause, when recognition of this kind was once established other authorities followed suit, and since that date one of the important cities of our country has each year been official host for our annual Conference.

One of the most marked ways in which the success of the Society's work can be seen is that nearly 400 local authorities, including nearly all the larger and smokier towns and districts, are subscribing members. However, this is not enough and we should like all local authorities to be sufficiently interested in smoke abatement to become members of the Society.

Another important event which should be mentioned is the Exhibition which was held at the Science Museum, South Kensington, in 1936, and was opened by the Minister of Health, while a Conference held in conjunction was opened by the Secretary for Mines. The Exhibition greatly helped the Society and brought it to the notice of many scientific and technical organizations.

One consequence of the increased publicity was the move of the headquarters from Manchester to London and it is not the first progressive movement which has been born in Manchester and has transferred to London when the movement has developed and is ready to expand on a national basis. London after all is the heart of the country whence the great arteries can pump the message to all parts of the body-politic.

One very valuable aspect of the Society's work lies in the quarterly journal *Smokeless Air*. I think everyone will agree with me that it is a most excellent paper, well edited, well produced and full of interesting information—in fact, it is one of the Society's most valuable assets.

Advance in the Society's work was well sustained until the war clouds began to throw their pall of darkness over all progressive work. Then followed the six years of war—years during which one might say that the production of smoke in new and frightful ways was the chief objective. But there was one interesting development as a result of the war—it was found during the Battle of the Atlantic (that period which was perhaps the most critical and perilous of all the war) that the smoke from the merchant ships in convoy could be seen on the horizon by enemy submarines before ever the ships appeared. And this did lead to the ships being fitted with some smoke eliminating device. Not being a technician I cannot give you scientific details but I know that something of the kind was actually done.

It speaks well for the enthusiasm and determination of the members and staff that the Society through those years of waiting managed not only to keep its head above water but to take an active part in ministerial discussions on the post-war problems of reconstruction and planning and housing.

The result of this steady, persistent work was evident after the war when, for instance, the numbers attending the annual conferences rose from the pre-war 100 or 150 to about 400.

I think one of the main reasons for that growth has been the linking of

the smoke abatement movement with the fuel efficiency drive. As a member of the Fuel Efficiency Committee of the Ministry of Fuel and Power, and as Chairman of the Domestic Coal Consumers' Council, I know just how important the efficient use of fuel is.

It was shocking enough in the days when the country was prosperous and coal was cheap and easy to come by, that 10 million tons a year should be wasted by just going into the air as smoke and soot and acid—shocking when one thinks how coal is obtained, of the gruelling toil involved in that labour underground, work that none of us would care to spend our lives doing.

I have been down a coal mine so I know just a very little about it. I walked half a mile bent in half and banging my head at intervals on the steel girders and finally crawled on my hands and knees 100 yards over broken coal to reach the coal face where the men were working.

Naturally, when it comes to strenuous exertion I am not comparing myself to those hardy men, but however tough they are, everyone will agree that it is a cruel and wicked thing to waste the results of such toil.

If that were true a generation ago, how much more true it is today, when our very national existence, our export trade (which means food and other necessaries of life) depend to a very large degree on the efficient use of coal.

Another subject which is very much in the fore-front today and will I believe, be even more essential in future years, is that of labour-saving in the home. It is not just that everyone more or less has to do their own chores in these days but that women are taking an ever increasing share in the public and cultural life of the country—a change which, I am sure, no one here would dare deny to my face, is very much for the better.

I know when one has some physical handicap—or pain—one gradually gets used to it and accepts it and that is merciful. But it is rather sad the way people do accept a quite unnecessary burden uncomplainingly because they have never known anything better, or because they have borne it so long that they have forgotten that it is a burden. There is such a thing as divine discontent. So many people accept the dirt and unpleasantness of smoke just out of habit, never realizing that it is something that can be got rid of.

In my position as Chairman of the Domestic Coal Consumers' Council I have spoken at a number of conferences on the efficient use of coal in modern appliances. I shall never forget one conference—it was at Bristol—and the passionate outburst of a working woman in the audience during the open discussion.

She said, "I am glad I came here today. It wasn't easy to get away but I'm glad I came. When I think of all the years of dirty back-breaking work I and countless other women have endured, it is good to know that better things are coming. I shall not live to benefit by them but our daughters will not have to put up with what we have had to."

I am out for anything which will help the women in the small homes who carry such a heavy burden, and it is good to know that the day will come when they can be relieved of the labour of open coal fires and old-fashioned coal ranges.

One of the first causes of stimulating production of smokeless fuels and of modern solid fuel burning appliances was the open criticism of this Society of the old-fashioned coal fire and of the wasteful use of bituminous coal, and the demand for more modern, smokeless heating in the home. As may be imagined this led to lively opposition in some obvious quarters with the result of good propaganda for this Society and a great stimulation of research and development in the domestic heating situation.

But how much still remains to be done. Of the two hundred million tons of coal mined in England every year nearly one quarter is still burned on open fires, in grates of the most antiquated design, that have existed without improvement for 50 years or more. One has sympathy with the Lancashire

woman who in response to a friend who was showing off with pride her Adam fireplace, said : " Ey, lass, I've got one older than that. The original Adam designed mine."

Open coal fires have become the English tradition, though it was not always so. They came only because wood had grown too scarce and expensive, and at first, until they became a habit, were looked upon with distaste.

One of the 17th Century chroniclers tells us that " Within thirty years past the nice dames of London would not come into any houses or room where sea coals were burned, nor willingly eat of the meat that was either sod or roasted with the coal fire."

Nowadays, many " nice dames " and nice gentlemen too, are apt to speak as if they could not exist without an open fire : they must have something to poke ; they must have something to look into ; the fire is the centre of the family circle and so on. It is even suggested that to do away with the open coal fire would strike a blow at British family life. Well, one does not see those roaring blazes in other countries and I refuse to believe that this country has a monopoly of happy marriages. Really if the person in the armchair on the other side of the fireplace is not just what is wanted, the rosy fireglow is not going to make all that difference.

In time there may be appliances that will burn coal without any smoke, but at present complete domestic smoke prevention is possible only in so far as we will, firmly and completely, determine to use the smokeless alternatives.

Firstly, there are the coals that are naturally smokeless, of which anthracite is the best and the best known. Between anthracite and the smoky bituminous coal there lies a range of hard intermediate coals, mostly from South Wales, that are either smokeless or nearly so. These, like anthracite, are excellent for closed domestic appliances, but are unfortunately dearer than ordinary coal and are likely to remain scarce because they constitute a popular and profitable export. The Simon Committee on " Domestic Fuel Policy " urged the Government to " take active steps to secure a very large development in the supply of anthracite and dry steam coal," and I wish that this could be done—and not only for the sale of the export market. At the present time a large proportion of anthracite goes to Canada and we cannot wish it otherwise as we get wheat in exchange.

Then there are the coals made smokeless by carbonizing them at high temperature in gas works and coke ovens, or at lower temperatures in patented processes. By these means we get coke and the semi-cokes such as Coalite and others. All are valuable for domestic purposes, and although the quantity of the semi-cokes is relatively small, coke has this year been in good supply in most parts of the country and has been freed from all rationing restrictions. The semi-cokes will burn easily in any type of fire, stove or boiler, but for open fires coke itself generally needs one of the new grates designed to suit it, though it can be started with a gas poker. Some people still think of coke as coal with the " goodness " taken out as gas. But this of course is a fallacy. The volatile matter that makes the gas would otherwise make the smoke, and would so be wasted, while the carbon that is left as coke is the part of the coal that makes the fire hot and glowing. A coal fire, in fact, is not at its best until it has become a coke fire.

The present output of the semi-cokes is already fully absorbed, and although the output may be extended later, most of the advances we can expect in the near future in the replacement of coal by solid smokeless fuel must depend on gas coke.

The crux of the matter is that coal should not be burnt domestically in its raw state. I wonder whether the National Coal Board in their new price structure have considered the possibility of making bituminous coal supplied for domestic purposes more expensive and making a corresponding reduction in the price of coal supplied to the carbonizing industries to enable them to supply cheaper smokeless fuels. I hand this idea to the National Coal

Board free of charge and I hope they will consider it.

Some people ask why, with all the evil that does exist in the world, we are anxious to give our time to this matter of smoke abatement—or as I should prefer to call it, smoke abolition. A friend said to me recently, " There is no need for it now. We don't get the fogs that we used to." Of course, foreigners do not think like that. They still picture England as eternally shrouded in a pea soup fog. I have just returned from France and there at Le Havre, almost within sight of the English coast they said to me, " N'est ce pas qu'en Angleterre il y a toujours du brouillard ? "

It is true that even in the worst November, fogs are not now what they were but it is also true that 2½ million tons of soot is projected into the atmosphere every year and it is impossible that that should happen without its having a deleterious effect on the health of the people. Even ten years ago, the death rate from lung diseases nearly doubled after a week of fog. Good health, particularly for the children of the nation, is I think one of the things really worth working for and it is one of the chief reasons why I am interested in smoke abatement.

Some people talk of the romance of fog. It has even been seriously represented to me that fog and mist are an inspiration to the artist and that the Art of countries like England and Holland owe much to the misty climate. This has another and much more practical aspect which will be realized by all who consider the damage done to beautiful buildings and works of art by smoke. Think, for instance, of the lovely old 18th century buildings in Bath, which are disfigured with smoke from Bristol 15 miles away. All over the country beautiful architecture is being ruined in this way and I think that smoke, far from being an encouragement, is a menace to beauty.

Of course, one of the main reasons for the decrease in fog is the enormous increase in recent years in the use of gas and electricity. Both are smokeless and both have labour saving qualities that make them especially welcome in the home. In spite of problems of production, peak and seasonal loads and the economic aspect, I think we have not reached the limit in which gas and electricity, with the support of solid fuel, can be used.

A newcomer is district heating, still in its experimental stages in this country, and which may possibly be an important method for new housing and mixed estates. District heating still has to prove itself on the question of cost and there are other practical problems of economics to be solved. Mention must also be made of the recent experiments in warming the whole house from a single heat source ; here again expense is at present a serious problem.

These and other developments show the modern trend that makes a break away from the traditions of the past towards greater comfort, cleanliness and labour saving.

Although we know how we may attain complete domestic smokelessness, and although the Society's own proposals were so gratifyingly endorsed by the Simon Committee, there are still many difficulties to overcome in having the policy implemented.

Briefly, this policy must be to ensure that all new houses are equipped with modern, approved appliances that can burn smokeless fuels. As soon as possible there should be a general replacement of obsolete grates and appliances by the new in existing houses—a big undertaking that is needed to save fuel as well as to reduce smoke. Full economic use of gas and electricity must be urged, and the newer schemes given a fair trial. At present there is not sufficient smokeless solid fuel for all our future needs, and we must support the Simon Committee recommendation that " the Government should encourage the largest practicable increase in the production of smokeless solid fuels suitable for domestic purposes."

Another recommendation of the Simon Committee urged that subsidies should be granted by the Government " to encourage widespread and rapid action " in the replacement of obsolete

appliances. So far, only the City of Salford, in its plans for Smokeless Zones is proposing to subsidize such replacements, towards which the sum of £10,000 has been approved.

The Society's proposals for smokeless zones, initiated by our Chairman, Mr. Charles Gandy, in 1935, are making headway and already we have the first pioneer zones being actively planned, some of which will include dwelling houses. In such smokeless zones all smoke will be forbidden, and because they can start as quite small areas and expand if necessary quite slowly, it becomes far easier, financially and administratively, to modernize fuel-burning equipment and arrange for the supply of smokeless fuels. Unlike any national enactment that could only be made effective at some distant date, smokeless zones can be begun here and now, because they can be concentrated, so to speak, on the areas that need smoke abatement most. Ultimately, of course, we hope all the separate zones will grow and meet and merge until at last they cover the whole Kingdom. But that is looking very far ahead.

If we look at our final, and still distant, goal of a land completely free from smoke, we must ask ourselves whether we want to legislate against smoke from household chimneys as is already done in respect of non-domestic.

To some people, who have not fully considered all that the community suffers from smoke, this may seem rather drastic. As a matter of fact, it is no more drastic and indeed rather gentler than what the Americans are doing—and their love of liberty is as great, and perhaps rather more vocal, than our own. There, in such cities as St. Louis and Pittsburgh the use of bituminous coal is permitted only for approved, mechanically-stoked appliances, and the fuel merchant, who has to be licensed, is not allowed to sell such high-volatile coal except to licensed users. All others, including householders, must use smokeless fuel as defined by volatile matter content. There, they have in effect made whole cities into smokeless zones at one step. Here, we are proposing only to feel our way, in typically British fashion, in quite small areas ; ready to profit by experience before deciding on the next steps.

This is a wide subject and I have tried to deal with it largely from the domestic aspect, which I think is only fitting from a non-technical person speaking to an audience largely composed of experts. When it comes to talking of better heated and cleaner homes, I feel I am on safe ground.

I have tried to show that this subject of smoke abatement is concerned with many of the most important aspects of life—with national economy, through fuel efficiency ; with labour saving in the home ; with the health of the people and with the preservation of beauty in the form of historic buildings. I hope I have made you feel, as I do feel myself, that it is a movement with which anyone may be proud to be associated.

The First Des Voeux Memorial Lecture

TOWARDS THE BETTER USE OF COAL

By D. T. A. Townend, D.Sc., Ph.D., F.R.I.C., Pres.Inst.F.

1. INTRODUCTION

IT is a great honour and privilege to inaugurate this series of lectures, which has been established to perpetuate the memory of a distinguished physician, Dr. Harold Des Voeux. He was one of the principal founders of the Smoke Abatement movement initiated 50 years ago, and became the first President of your Society when it was formed in 1929 ; he remained in that office for 14 years and died in harness just seven years ago.

On the hard journey of the first 30 years of your movement, Des Voeux was, I understand, accompanied by another great pioneer, Lawrence Chubb. I have noted with interest that Chubb did great work for the commons and footpaths preservation, as well as for the national playing fields, movements. I think that these two names can very appropriately be joined with that of William Willett, the great pioneer of daylight saving ; for it seems there is much in common among the three men in the kind of service which they gave their fellow men so unsparingly. The recollection of their work gives a timely reminder that there are things worth striving for above and beyond those material objectives with which we are wont to become so preoccupied in these present times.

The right to be remembered with honour is one which is due to all pioneers and prophets, but one which is not in fact always accorded to them, even posthumously. The decision of your Society in the year of its coming of age to establish these lectures in memory of your distinguished founder appears to me to have been an exceedingly happy one, and I am the more pleased, therefore, to have a part to play in this act of public remembrance.

The lectures are intended to place the special subject of your Society in perspective against a background in which are found history, science, medicine, culture, the arts and social reform ; and I know that naturally on this occasion you will expect me to provide the particular background, science. I have also been asked to address you on the idea and the story of the better utilization of coal, illustrating the steady evolution of new conceptions in relation to scientific endeavour ; and perhaps illustrating these from the work of my own organization, the British Coal Utilization Research Association, one among others now active in this sphere.

2. COAL AMONG FUELS

The chief energy sources upon which we rely in this country at the present time are coal and oil; coal provides nearly 92 per cent., imported oil about 8 per cent., although the latter figure will no doubt rise over the next few years. The coal equivalent of our limited developed water power is about 0.5 per cent. The usage throughout the world is roughly: solid fuels 58 per cent.; liquid fuels 37 per cent.; and water power 5 per cent. With such an overwhelming dependence upon coal, we obviously cannot escape the necessity for taking great interest in how we use it.

We find rather a different position in the United States where solid fuel provides about 49 per cent., petroleum and natural gas together 46 per cent., and developed water power about 5 per cent. Although coal is still the largest single source of energy, the increase in the use of liquid fuels has been great; thus, between 1918 and 1942 coal consumption remained fairly constant, but that of oil increased fourfold, and of natural gas sevenfold. As you see, the economy of the United States during recent years has become very dependent upon mineral oil. But the consumption of mineral oil has now overtaken its production, and the United States has, in fact, become an oil-importing country. Moreover, its oil reserves are uncertain, and the view has been expressed that they may well have almost vanished within the next century and possibly earlier. Great energy has been devoted in the United States to study the development of oil, but now the emphasis is beginning to shift in the direction of coal, so that already, the scale on which research on coal is being conducted exceeds that in our own country.

The following summary given by J. G. Bennett in 1944 (First Arthur Reavell lecture to the Institution of Chemical Engineers) of the distribution of dynamic carbon (i.e. carbon in organic form) in the earth's surface may here be usefully recalled. The figures relate to "an approximate estimate of the quantities within reach of man's exploring."

Coal (including lignite as coal)	12	
Petroleum ...	0.07	
Timber ...	0.008	$\times 10^{12}$ tons
Foodstuffs (1 year's production) ...	0.00055	

More recent surveys suggest one half the figure given for coal and nearly twice that for petroleum, but the striking preponderance of coal is not materially altered.

We are conscious of the furious rate at which we, and the world in general, are at the moment consuming our natural fuel resources. It has been put vividly that in a year we consume as much coal as would bury the whole city of London to the height of its tallest commercial buildings and that the total we have consumed over the past century would have covered the whole area of Britain to a depth of between 4 and 5 inches. The question is often asked how long can this continue; but the various surveys recently made are, in fact, fairly reassuring. Our own reserves are reckoned to be adequate for at least 200 years, assuming the rate of production to continue at roughly the present level.

We have been warned that the position in regard to some of our special coals, for example, the best coking coals, is less satisfactory, but a recent review by Dr. J. G. King suggests that future supplies of the coals required by the Gas Industry are not likely to be in doubt for some time yet. Some reference is appropriate here to the remarkable progress made during the last few years with the coals of Lorraine. Before the recent war, coke ovens serving the steel industry in this area had found local coals mostly unsuitable. In 1938, over 90 per cent. of the 2½ million tons required annually were therefore imported. As a result of systematic studies begun during the war, however, it has been found that over 75 per cent. of these local coals are, in fact, quite suitable for coking purposes *if suitably blended.* This illus-

trates how profitable it is to face problems; indeed, with more understanding of coal and its varying properties, we need have few fears of finding ways and means of using almost any type of coal for any ultimate purpose.

What other natural sources of energy are likely to become important in relation to coal in the reasonably near future? This has often been asked, and you are probably familiar with the many suggestions which have been made as to the potentialities of, for example, wind power, tidal power, the heat of the earth and of the sun, etc. One does not, I think, visualize any early significant developments in these directions, although there are, of course, a number of successful examples. One of the latest which comes to mind is the work being carried out under the French Government for the utilization of the heat of the ocean off the West African coast. Atomic energy has also to be considered, but great problems concerning its utilization still await solution. Sir John Cockcroft dealt with some of these in a paper to the World Power Conference, held in London last July; and a useful appraisal of the present position was given to this same Conference by W. F. Davidson from the U.S.A. He said that although there are grounds for anticipating eventual solutions of the technical and engineering problems, they are proving much more difficult to find than was expected a few years ago. He went on to say that "there now seems to be little reason to expect that nuclear power plants can compete on a cost basis with power plants using coal, other fuel, or water power, for at least several decades."

Perhaps the most serious problem facing us is to maintain at the necessary level the rate of winning our coal. During the century preceding 1913, we enjoyed a steady rise in output. In that year, it reached 290 million tons (or 7 tons per head of population), of which 87 million tons were available for export. Much has happened since then, and to-day production is at the level of slightly over 210 million tons (or 4 tons per head of population); indeed, we are barely able to maintain it at this level. Dr. A. Parker has recently stated that the coal equivalent of fuel consumption per head of population in the U.S.A. has now reached the figure of 8 tons per annum. I cannot dwell here on this matter, but it must be obvious that our basic problem is manpower, and that progress in its solution is disappointingly, if not dangerously, slow.

3. MEASURES TO REDUCE WASTE

A remarkable paper was presented in 1946 to the Institute of Fuel by Mr. Oliver Lyle, under the challenging title, "Inefficiency." The author made a systematic analysis of the various modes of using coal throughout the country, and after examining the efficiency of each, he attempted an overall appraisal of the efficiency with which all coal is used; his conclusion was that this was no greater than 15 per cent. Without considering deeply the premises or the processes which the author adopted, it must be agreed that he advanced damning evidence of the degree of present waste. The problem of waste is not new, but when it is analysed, the result becomes a little frightening, particularly when it is remembered that 1 per cent. gained in efficiency represents a saving of 3,000 men at the coal face.

Much of our inefficiency is probably attributable to the extent to which past methods have tended to remain established, often through the high capital value of the plant involved; and this value has not been written off as it should have been.

There are three approaches by which improvement in overall fuel consumption has been sought: first, by improvements in practice and technology; second, by improvement in the organization of the fuel industries nationally; and third, by encouragement of the wider and more rapid application of science and scientific methods to fuel problems. I will refer briefly to each of these.

3. 1 Improvements in Practice and Technology

For at least three decades there have

been evident attempts in industry to improve fuel economy. Conditions during both World Wars encouraged fuel consciousness ; this was a main reason for the formation of the D.S.I.R. in 1917, and in 1942 it found expression in the formation of the Ministry of Fuel and Power. One of the early steps taken by this Ministry was to form a fuel efficiency organization which at once set out to achieve the more obvious ways of raising the level of fuel economy. The need for attention to the obvious was well exemplified in certain observations made by Sir Ernest Smith in the course of industrial pilgrimages during the late war, in company with Mr. J. S. Ronca, then of the Board of Trade. To quote Sir Ernest's own words, he and his colleague satisfied themselves, and also the *users* that " savings in consumption of gas could be brought about, varying from 5 to 50 per cent., simply by applying common sense in the use of furnaces." The many other activities in which the fuel efficiency branch of the Ministry of Fuel and Power has engaged are well known ; for example, much has been achieved by the education of operating staffs and by advice leading to the more efficient utilization of coal for steam raising—and, as you will be well aware from the work carried out at the Fuel Research Station, efficient combustion means less smoke. Indeed, efficiency and smoke abatement go hand in hand.

A serious technical problem arises from the almost bewildering variety of coals ; and a major step in aiding the solution of this problem has recently been taken by the National Coal Board by introducing a simplified system of coal classification. All the coals produced are now described with a simple system of numbers which specify the important properties and allow an estimate to be made of suitability for particular applications, e.g. steam raising, gas making, coke manufacture, etc.

We should, I think, also recall the progress brought about in technical education. No fewer than six universities or university colleges have, in recent years, come to provide degree or diploma courses in fuel technology ; indeed, at all levels of education there has been increased attention given to the subject. I should also refer to the formation of the Institute of Fuel in 1927 ; this body has exercised a steadily increasing influence towards the raising of all technological standards in fuel practice.

Some of the " Dividends of Fuel Technology " related under this title by Mr. W. L. Boon in his Presidential Address to the Fuel Luncheon Club last year are worthy of quotation : the electricity generating industry in 1927 consumed 2.43 lb. of coal for each kilowatt hour generated, in 1947 the figure was 1.51 ; the Gas Industry in 1925 produced 13,600 cu. ft. gas per ton of coal carbonized ; in 1945 the figure was 14,600 cu. ft. ; the Steel Industry in 1928 consumed 39 cwts. of fuel per ton of steel ingots and castings produced, and in 1948, 29 cwts. ; other examples were given in respect of the Shipbuilding and Chemical Engineering Industries.

3. 2 Organization of the Fuel Industries

The second line of approach to better national fuel usage has been through action at national level. The first notable event was the formation of the Fuel Research Board in 1917 ; one of its first important steps was to initiate a complete survey of the nation's coal resources. The second significant event was the formation of the Ministry of Fuel and Power, to which I have already referred. The third outstanding event has come within the last four or five years in the nationalization of the three great fuel industries, coal, gas and electricity. It is important to appreciate that before nationalization, these industries included many units with high standards of technical efficiency but the opportunity for these standards to become general was not great. Organization of these industries on a national basis should enhance the prospect of lower technical standards being raised and of the whole of each industry becoming more rapidly responsive to new technical and scientific advances. Indeed, under the Nationalization Acts

each industry is directed to foster research into the production and distribution of its own particular form of fuel, subject to co-ordination by the Minister.

3. 3 Application of Scientific Methods

The third line of approach is demonstrated by the development of industrial research organizations which work in free and full co-operation with the government and nationalized research bodies concerned. Among the main activities of the Department of Scientific and Industrial Research, which embraces all branches of science and all industries, except medicine and agriculture, are two types of research organization: (*a*) Wholly controlled research establishments, e.g., The Fuel Research Station, The National Physical Laboratory, etc., whose work is undertaken on behalf of the community as a whole, and (*b*) research associations, financed by the industries served, with the Government making a contribution through the D.S.I.R. There are now three well-established Research Associations, namely the British Coal Utilization Research Association (1938), the Gas Research Board (1939), and the Coke Research Association (1944). More recently, (1948), the Coal Tar Research Association has come into being. In addition, there are the British Refractories Research Association and British Iron and Steel Research Association, the latter being deeply concerned with all sides of steel making, including fuel problems ; and finally, there is the important Research Organization of the National Coal Board, now being rapidly developed, and catering for all problems concerned with the winning and preparation of coal. It would take too much of your time to cover thoroughly the activities of all these and other bodies, and to outline their respective interests. It is sometimes suggested that there are too many units engaged in fuel research to ensure efficiency in the national effort : sometimes, in fact, that these units overlap. I believe firmly that this is not borne out in any way by the facts ; close and friendly mutual relations exist, and where there is overlap, it is invariably on problems which are too important to be left exclusively to one team, large or small, or to one school of thought.

The British Coal Utilization Research Association, with which I am the most closely associated, is in many ways unique among these associations. It seeks to serve no single well-defined industry, but indeed every industry using coal, in other words practically the whole of industry. It is founded on a conjunction of interests : firstly, the coal producer, the National Coal Board ; secondly, the coal user, ranging from the British Electricity Authority down to relatively small industrial concerns ; thirdly, the appliance maker, which again ranges from the maker of the largest steam raising plant down to the simplest domestic fire grate ; and fourthly, the coal distributor. The Association's membership includes all these elements in an autonomous association belonging in a very real sense to industry. All the different interests have influence on the scope and direction of the programmes of work undertaken.

It is strange though significant, that whereas in the decades just before and after 1900 British industry tended to avoid science and rely upon practical engineering art, the need for the scientific approach to problems of industrial fuel usage is now more thoroughly appreciated. This is shown by the movements to which reference has been made. But the national effort in coal research as represented by the various agencies mentioned is still on a relatively modest scale. It was stated in the House of Commons recently, that the total annual expenditure amounted to roughly £1 million, or 1¼d. per ton of coal. Research in this country on oil amounts to at least £0.5 million per annum corresponding with more than 7d. per ton, and coal research in France has been financed since October, 1948, by a levy of 12 fr. (3d.) per ton.

When we remember other large-scale national expenditure, and having in mind that £1 million per annum is the

approximate equivalent of the aggregate cost of one cigarette *every four months* per head of the adult population, this position, I think, calls for serious thought—particularly in view of the importance of coal research in all its aspects to our present national economy.

end of the last century a scheme had been developed, which included most of the principal types of coal from peat to anthracite, and related them according to their chemical analysis and characteristics, roughly as shown in the following Table.

Type of Fuel	*Carbon per cent.*	*Hydrogen per cent.*	*Oxygen per cent.*	*Nitrogen per cent.*	*Moisture as found per cent.*	*Volatile Matter per cent.*	*Calorific Value B.Th.U./lb.*
Peat	45—60	6.8—3.5	45—20	0.75—3.0	90—70	75—45	7,500—9,600
Brown coals and lignites	60—75	5.5—4.5	35—17	0.75—2.1	50—30	60—45	12,000—13,000
Bituminous coals ...	75—93	5.6—4.0	20—3.0	0.75—2.0	20—1.0	50—16	12,600—16,000
Anthracites	92—95	4.0—2.9	3.0—2.0	0.5—2.0	1.5—3.5	12—3.5	16,000—15,400

4. SCIENTIFIC STUDY OF COAL

The scientific study of coal is a comparatively recent development. It seems strange that this should be so in the light of the often-quoted and elegant comment of George Stephenson nearly a century ago that " the Lord Chancellor now sits on a bag of wool, but wool has long since ceased to be emblematical of the stable commodity of England. He ought to sit on a bag of coals." The truth is, however, that both chemically and physically coal is a very complex material ; by comparison petroleum is composed of hydrocarbons, the chemical nature of which has always been well understood. Only some twenty years ago did we begin to understand the chemical nature of the cellulosic and lignitic components of the vegetable tissues from which coal was formed in geological times. Even to-day scientists are only just acquiring an understanding of synthetic fibres and plastics and, in turn, of their naturally formed counterparts.

4. 1 The Approach of the Analyst

The earliest studies of coal made use of analytical chemistry and they probably began soon after Bunsen initiated his famous methods of chemical analysis in the middle of last century. The first attempts were directed to practical ends, namely, how to recognize coals and to arrange them in relation to one another. One may recall the efforts of Regnault, the French scientist, and later, those of Gruner, the French engineer. By the

The bituminous coals are those which hitherto have been most easily adaptable to industrial uses. Great Britain, although possessing merely 2 per cent. of the world reserves of coal, fortunately has been richly endowed with bituminous coals and to a much less extent some anthracites ; but 70 per cent. of the world's reserves located widely in other countries consists of inferior brown coals and lignites.

My colleague, C. A. Seyler (now in his 80s and still active), writing in 1900 on the ideas then current said " coal is classified commercially in a number of ways, varying with local usage and founded either upon characteristic appearance—as in the case of ' cannel,' ' anthracite ' or ' splint ;' or upon manner of burning and the nature of the coke—as in the case of ' free burning,' ' open burning,' or ' non-caking ; ' or upon the nature of the flame as ' smokeless,' ' short ' or ' long,' etc. All these terms are very vague and ill defined and their multiplicity confusing." Attempts to form a satisfactory classification are still being pursued even to-day. The purely analytical approach has not led to any complete understanding as to why certain coals differ so considerably from others, in many cases the differences in their chemical analyses being relatively small.

Attempts to elucidate the structure of coal, have followed three principal directions. First, to approach coal as a chemical, the complexity of which might be revealed by the processes of

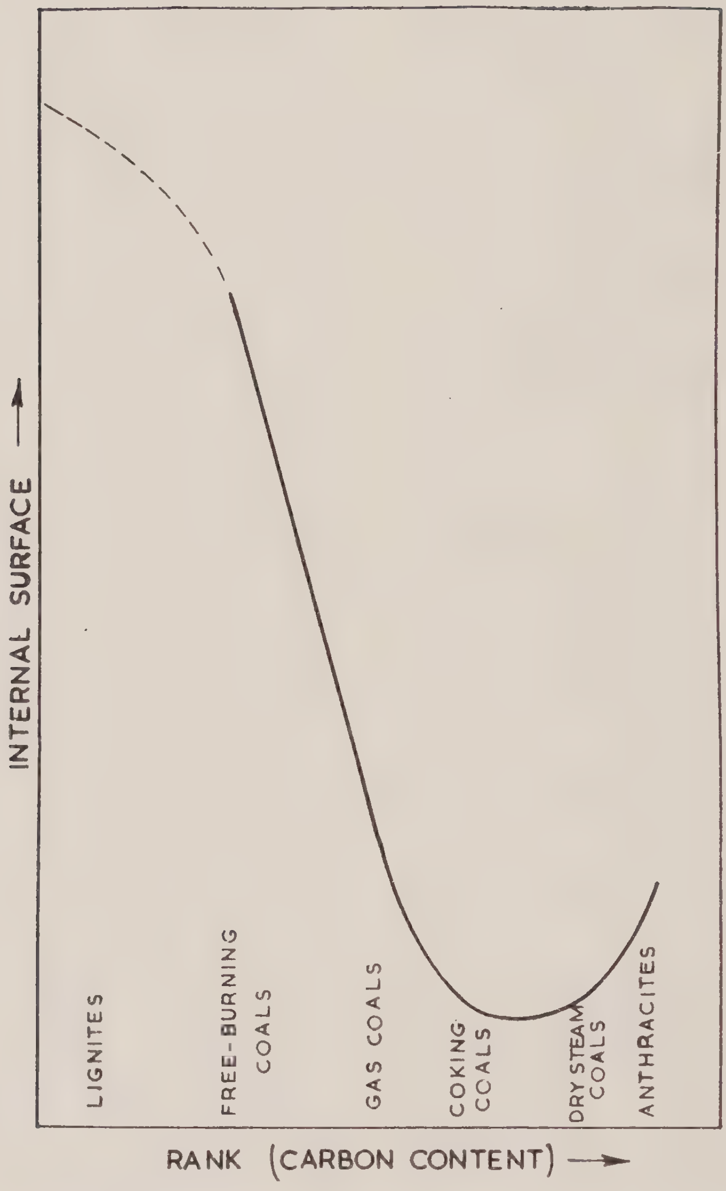


Fig. 1. Variation of internal surface of coal in relation to its character

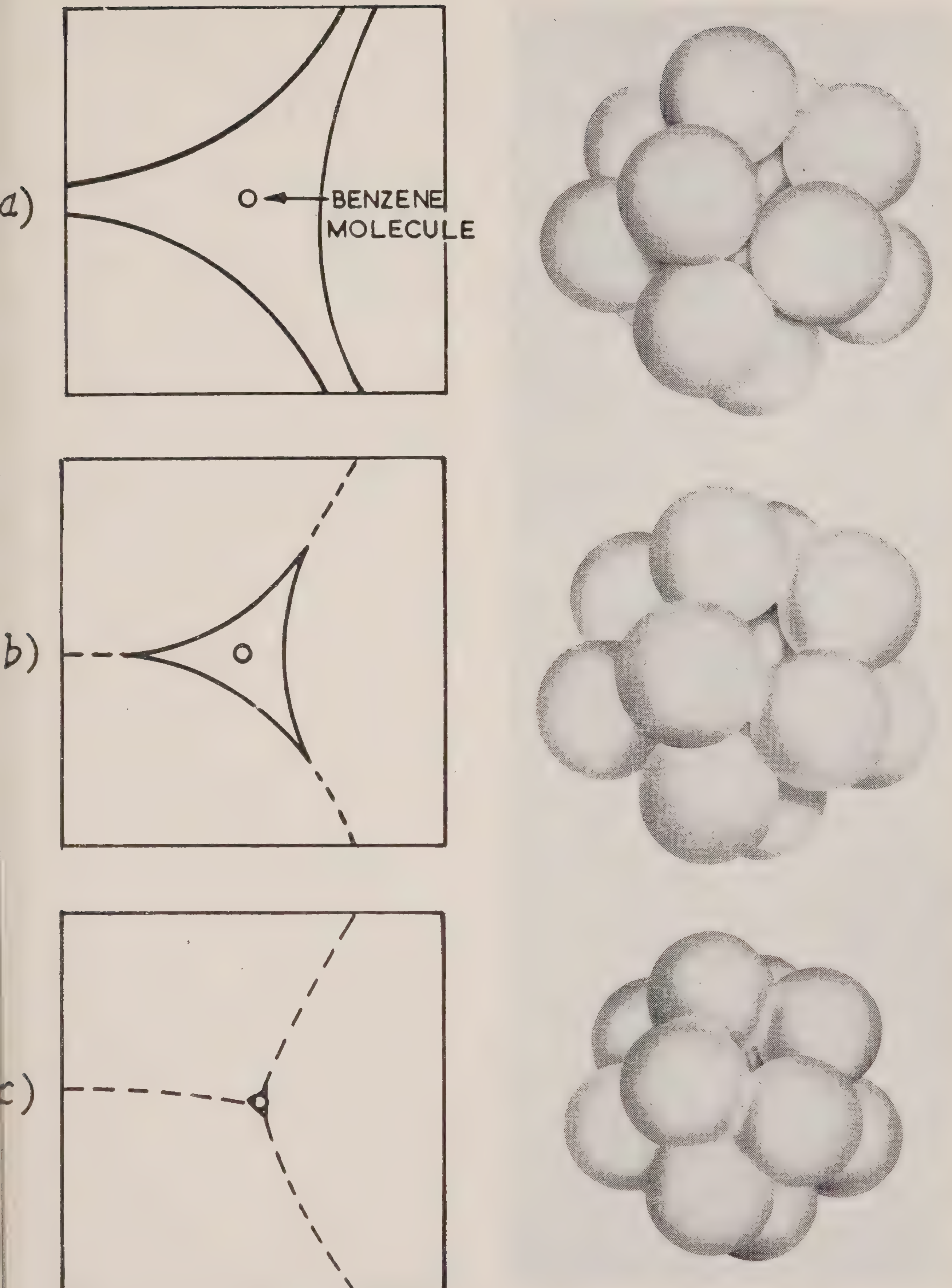


Fig. 2. Successive stages (a), (b) and (c) of the compaction of coal micelles —corresponding with increasing maturity—due to the influence of pressure and temperature in geological times. The size relation between the pores and a benzene molecule is indicated

chemical destruction or fractional solution. One calls to mind here particularly the work of Wheeler and others on the extraction of coals with solvents, as well as that of other investigators who had hoped to find clues from the results of the thermal decomposition of coal during its carbonization ; but the latter approach has been disappointing. Incidentally, mention should here be made of the researches of H. L. Riley using X-ray methods ; these have done much towards providing an insight into coal structure. Considerable information has been accumulated about the way in which oxygen, sulphur and nitrogen occur in coal, but much of the experimental evidence is of a type which can be catalogued but not readily understood. The basic carbon structure of the molecule, for example, is still a matter of controversy.

4. 2 The Approach of the Geologist

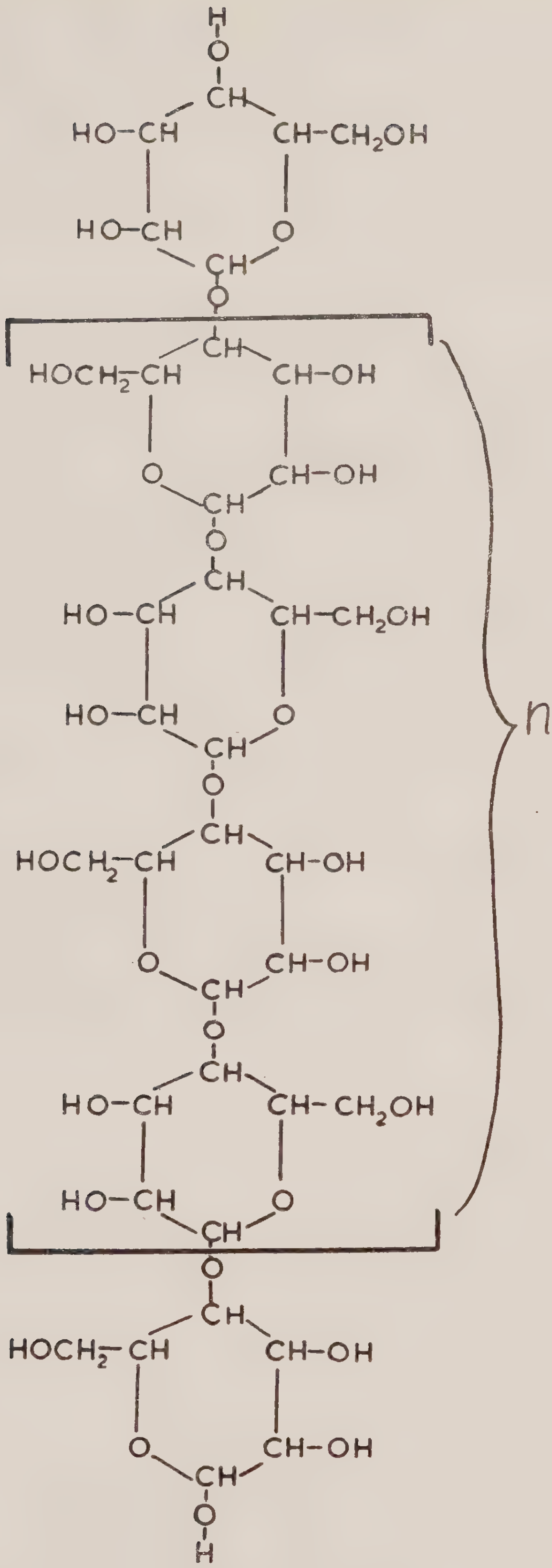
The second line of approach was that of the geologist and was initiated principally by Marie Stopes about 1919. She drew attention to the presence in coal seams of bands with remarkably differing lustre and hardness. These "rock types" she named vitrain, clarain, durain and fusain. Vitrain, glossy black, consists mainly of ulmin materials from cellular plant structures ; durain is dull and hard and is formed from mixed plant debris with some ulmins ; clarain is a bright coal constituent intermediate between vitrain and durain ; fusain is opaque soft fibrous material similar to charcoal and probably the result of forest fires or has suffered from spontaneous combustion at some time during its formation. The bands were not, however, homogeneous, and in the 1930's much discussion took place on the idea of "macerals." It was suggested that just as in the rock, granite, there are several constituent minerals, such as mica, felspar and quartz, so in the rock, coal, there were several constituent "macerals."

About that time Stach in Germany improved the technique of coal microscopy by resorting to the use of oil immersion lenses. He found that these made visible on polished coal surfaces greater detail than was obtainable by the use of etching or thin sections. This observation came to the notice of Seyler and as the outcome of many years of study, he has reported the occurrence of nine different components each with its characteristic reflecting power to light ; and he has been able to develop a technique for measuring the different proportions of these present in different samples of coal. The exact scientific interpretation of these observations is not yet clear, but they have led to some remarkable conclusions on the processes of coal formation, and also of coal carbonization.

It should be emphasized that while these petrological advances are of great practical importance in discriminating between coals, as yet they have thrown no direct light on the constitution of the coal substance. One broad conclusion is that the principal component in bright coals, vitrinite, represents from the point of view of the chemist the most characteristic material, and has the greatest claim among all constituents to the name "pure coal."

4. 3 The Approach of the Physical Chemist

The third approach has been that of the physical chemist, and was initiated by the late Dr. D. H. Bangham shortly after he joined the staff of B.C.U.R.A. in 1938. It had already been appreciated that certain features of the behaviour of coals, e.g., their inherent moisture content, suggested a colloidal structure, and that lumps actually consisted of an assembly of small particles, probably too small to be visible under the microscope, but which imparted to the lump a porous structure. Bangham introduced a number of methods which at that time were entirely new in their application to coal. These led to a considerably greater understanding of its internal structure and it has since been possible to develop a fairly clear picture of the colloidal structure, and to express this in a definite model. According to this, the younger coals can be approximately represented by an assembly of very small and nearly



THE CELLULOSE MOLECULE

n REPRESENTS THE VARIABLE NUMBER OF REPEATING UNITS IN THE MOLECULE

Fig. 3. Chemical structure of the cellulose long chain molecule

spherical units packed closely together. Under the influence of pressure and temperature these units became more closely pressed together, their points of contact became flattened and the interstices reduced in size. The availability of the internal surface to gas and liquid molecules becomes less as coals increase in maturity reaching a minimum value with the strongly caking coals. As the rank of the coal increases still further to the anthracites there is some opening up of the structure possibly due to the loss of peripheral layers from the colloidal units.

From measurements made by Bangham's methods, it seems likely that the internal surface area accessible to molecules of the common gases varies from 20 to 200 sq. metres/grammes (from 2 up to 20 acres/lb.) according to the rank of coal. Apart from the consequences of this vast internal surface in relation to the behaviour of coal with oxygen and other gases, it carries with it an important implication regarding its physical strength. If we imagine a cylinder of material of the same density as coal and weighing about $1\frac{1}{2}$ ozs., stretched until it had the same ratio of surface to volume as is found in a low-rank coal, we should need to stretch it all the 93 million miles to the sun. It would then be very thin and very weak ; and a single layer of water molecules on the surface of such a filament would increase its diameter by 5 per cent. and would further weaken it. At once it is seen that this vast surface area in coal makes it very vulnerable to simple physical forces and also to chemical reagents, provided that they have unrestricted access to the surfaces. It is in this that hope lies of finding entirely new ways of studying and of treating coal, less violent and more controllable than, for example, thermal decomposition. Agents for this may be new solvents recently discovered within the B.C.U.R.A.

The *accessible* internal surface of coals varies considerably with the maturity or rank of a given sample. The manner of variation is shown in Figure 1 ; there is a pronounced minimum in the region of the strongly caking coals. On the left-hand branch of the curve, the porous structure can be satisfactorily interpreted on a very simplified model (Figure 2) in which minute spherical units of structure termed " micelles "—which could have been formed while coal at an early stage of its formation was in solution in swamp water—are moderately closely packed together in the free-burning coals ; they were further compressed during the course of maturing to coking coals. At the same time as such physical changes proceeded, chemical cross-linking of the basic chemical components also took place with elimination of simple compounds such as water and methane.

We may now consider the relationship of these tiny micellar units to the still more minute molecules such as occur in the cellulose and proteins from which coals must have been largely derived. The molecules of these substances are made up from a large number of small molecules and atoms chemically linked end-to-end to form a chain ; Figure 3 shows how the molecule of cellulose is built up in this way, and Figure 4, how two units of this chain are arranged in three dimensions (Astbury ; " Endeavour," 98 ; **3** ; 1944). Chain molecules can form more or less globular micelles in at least two distinct ways—by folding and clustering, as with proteins (for example albumen), or (if they possess water-attracting heads and water-repelling tails) by direct radial packing as has been found to occur in strong soap solutions ; Figure 5 illustrates these possibilities. The chemical cross-linking mentioned would prevent the subsequent disintegration of the micelles ; it is a moot point whether the chain structure persists in a coal after this type of ageing or whether the cross-links have become equally as important as the original chain molecules, leading to a large molecule (macromolecule) with a three-dimensional network of links. We are not in a position as yet to choose between these various alternatives.

To sum up, we have evidence for the existence of a physical unit of coal

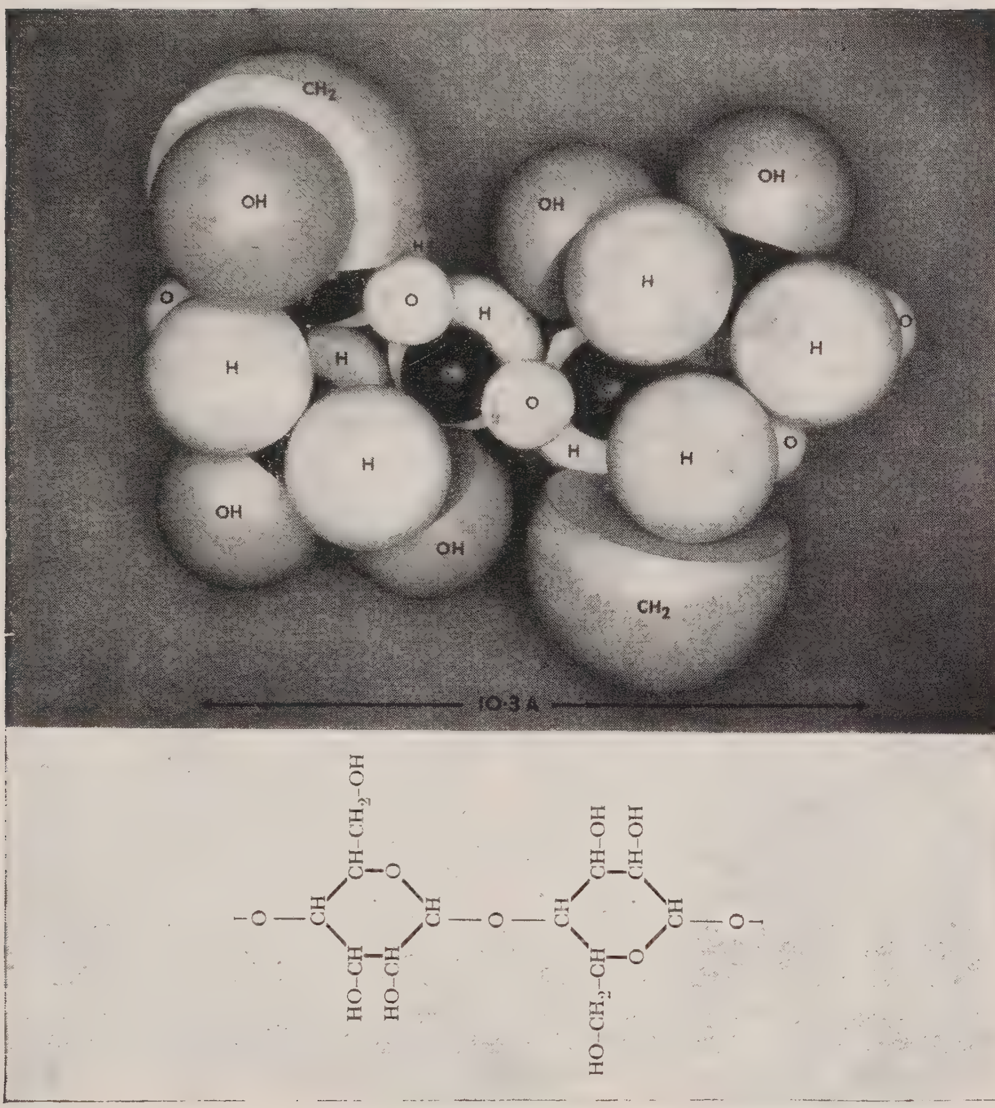


Fig. 4. Three-dimensional arrangements of two units of the cellulose molecule. (W. T. Astbury, F.R.S.). Reprinted by permission from " Endeavour," 98 ; 3 (1944)

structure (the micelle), and macromolecules within the micelle; and there is also strong evidence of a macromolecular unit on a scale about 1/10th of the micellar diameter. Finally there is the spacing between nearest neighbour atoms, which are on a still smaller scale. The structure of coal is very "disordered" compared, for example, with cellulose or proteins, and this makes it the more difficult to determine its precise character in comparison with that shown for cellulose in Figure 3. Very approximately, the scale on which the units of structure mentioned occur may be illustrated as follows; taking a typical spacing between atomic centres as equivalent to one inch, the diameter of a macromolecule might be comparable to a foot or more according to its shape, of a micelle about 3 yards, and of a grain of coal dust such as blows up in the wind about 5 miles. An ordinary lump such as we put on the fire would on the same scale measure about 5,000 miles across. If we consider the relative weights of units the contrast is still more striking. Suppose we take the weight of a particle of size comparable with the distance between atomic centres as equivalent to a small drop of water. The macromolecule would correspond to an egg-cupful, the micelle to a 10-gallon drum, the airborne grain of dust to a large water reservoir and the lump of coal to the Pacific Ocean. These examples illustrate the point that the macromolecules and micelles are not so very different in size whereas dust particles are on a vastly greater scale.

4. 4 Mineral Matter

The mineral matter which raises so many problems in the use of coal is partly intrinsic and partly extrinsic. The intrinsic material originated from the inorganic salts present in the structure of the parent vegetation, or absorbed by the plant, or washed down by rain. It is very thoroughly dispersed in the coal substance and some of it at least is probably in chemical combination with the coal. Despite this thorough mixing it is very unequally distributed both in quantity and kind between the various petrological constituents of the coal to which I referred on page 19 even when these components are from the same seam or even the same lump of coal. The extrinsic matter is of sedimentary origin or from infiltration into the coal beds after they were laid down; and the total mineral content of coals depends largely on adventitious inclusions. Extrinsic matter is the material that can be removed by coal cleaning. This process cannot reduce the content of intrinsic material which for British coals is usually not more than 5 per cent. and in some few cases is less than 1 per cent.

5. THE MECHANISM OF BURNING

Having devoted some time to discussing the porous character of coal, it is pertinent now to consider the importance of this in the process of burning. The overall stages of combustion are complex, but I will deal briefly with the following three main factors: (*a*) oxidation of the solid, (*b*) generation therefrom of carbon monoxide and the completion of its combustion to carbon dioxide, and (*c*) emission of volatile matter.

5. 1 Oxidation of the Solid

It will be clear that oxygen may react at the exposed geometrical surface of the pieces and also at their internal surfaces bounding minute inner pores. I have related how the total internal surface is enormously the larger, and recent experiments have disclosed how the internal surface is a determining factor in the rate at which fuels burn, or to use a technical term in their "reactivity." It is not suggested that internal surface is the only factor: for example, some of the mineral matter present in fuels accelerates the rate of reaction of the fuel not only during combustion but also during gasification in carbon dioxide and steam: indeed, you may remember that alkalis are sometimes used to "activate" fuels in the generation of producer gas and

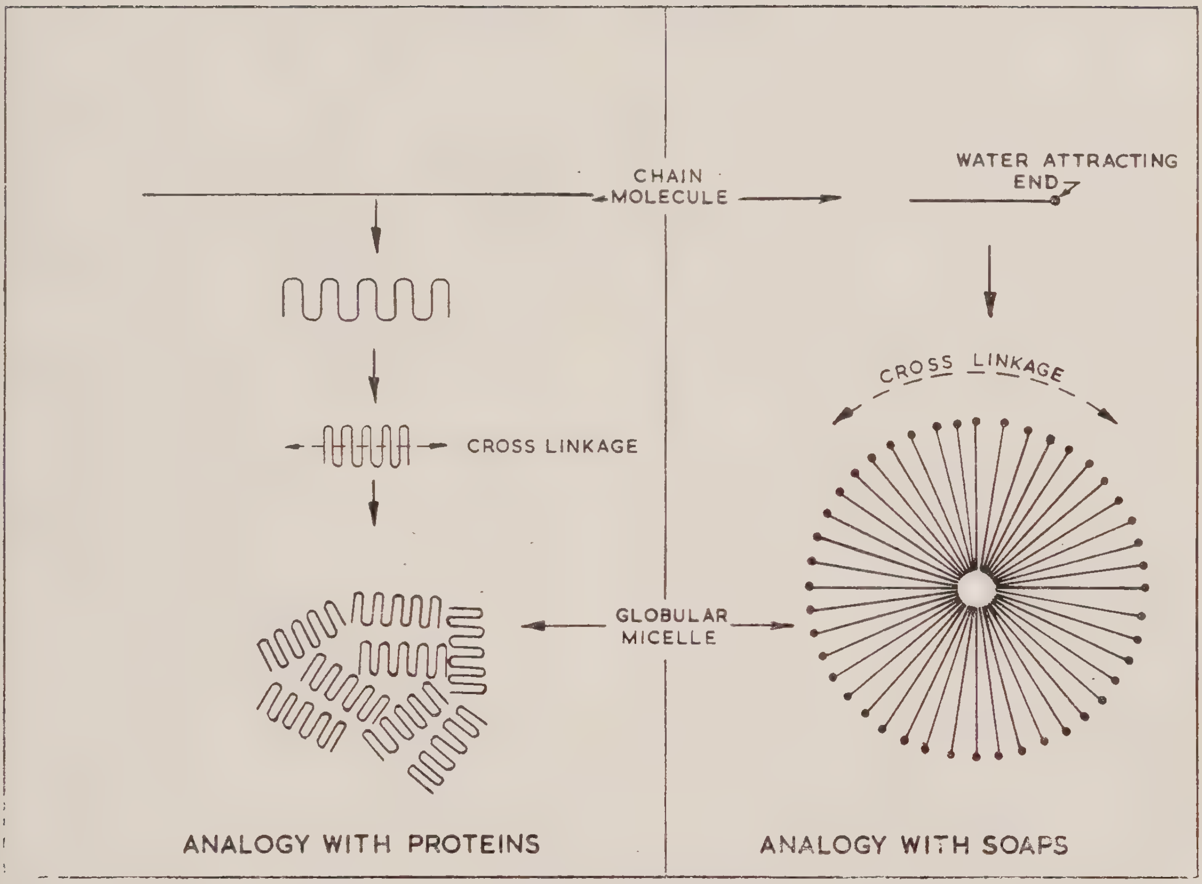


Fig. 5. The packing of macromolecules to form micelles

water gas. The fact that the internal surface plays a real part in the oxidation process during burning may imply that the pore size in fuel pieces increases during the process. Measurement of the density of partially consumed pieces has shown this to be the case; and under favourable circumstances, the external dimensions of a piece of fuel often remain practically unchanged until much of it is consumed. The extent of this phenomenon differs between fuel and fuel and has a determining effect on the mechanical strength of the partially consumed material.

The movement of oxygen into the interior of the fuel pieces as the latter are burning has also been demonstrated in another very direct way: a positive pressure amounting to an inch (water gauge) can be observed at the interior of a burning piece of coke. This pressure must result from the passage of oxygen from outside into the interior of the piece followed by release in the interior of the products of combustion.

The most important feature of the chemistry of the oxidation of solid carbonaceous fuels, and only clearly established by very recent work within the B.C.U.R.A., is that carbon *mon*oxide is the only primary product occurring at temperatures above incandescence. The formation of the ultimate product carbon *di*oxide therefore occurs in two stages: (i) generating of CO at the fuel surface, (ii) further reaction of CO with oxygen in the gas phase yielding CO_2. This is a matter of great importance when it is realized that the heat liberated in stage (i) is only two-fifths of that liberated in stage (ii). The burning of solid fuels is therefore largely controlled by the rate of burning of carbon monoxide, the primary product.

5. 2 The Combustion of Carbon Monoxide

Most of us learned some elementary chemistry in our school days and if we were lucky and the class had been well behaved we were shown the daring experiment of exploding hydrogen with air in a strong lemonade bottle; we had to take particular note of the drops of water left behind and we were taught that two molecules of hydrogen reacted with one molecule of oxygen to form two molecules of water ($2H_2 + O_2 \longrightarrow 2H_2O$). We also learned that flame travelled through the explosive mixture because the heat liberated by the chemical reaction raised the unburnt gases to the ignition point.

Our viewpoint has had to change very much in the last 25 years; for we now know that the meeting together of three molecules (tri-molecular collisions) at the same time is a very rare event compared with the meeting of two. How then do we get over the difficulty? Simply from the knowledge that water is formed only as a final product after a succession of mostly bi-molecular collisions between atoms, e.g. O and H, and molecular fragments (radicals) e.g. OH. Sometimes the process can be arrested or retarded by the presence of quite small amounts of a foreign substance; and to explain all this the scientist has invoked the theory of chain reactions.

A useful analogy is provided by considering the spread of an epidemic disease. If, in a large population, there is but one infected person, and if we suppose that he in turn infects the person who is attending him in his illness and no one else, the disease can affect only one person at a time. It will die out altogether if, for example, the infected person is killed by a taxicab before passing on the infection. The result will be quite different, however, if each infected person imparts the disease to two or more others before he either recovers or departs this world. We have then the conditions for the spreading of an epidemic: the disease will spread at an ever-increasing speed until the decrease in the number of uninfected persons brings it to a halt. A like process occurs in the combustion of gases and the "carriers" are designated active centres because, apart from the fact that they are highly reactive atoms or molecular fragments, we are sometimes ignorant of their precise nature. If the reaction is such that an active centre converts the

reactant molecules into their end products and in so doing regenerates one new reaction centre, the chain is described as a single chain; if more than one active molecular fragment is regenerated in the process, the reaction is described as a branched chain one. Incidentally, the invention of the atomic bomb depended upon the discovery of a branching chain process in the field of nuclear physics.

The progress of a chain reaction depends upon encounters between the molecules of the original reactants (e.g. those of carbon monoxide and oxygen) and the highly energized "carrier" species, rather than upon the prevailing temperature. A catalyst or promoter is a material which favours the formation of active centres and an inhibitor is one which puts them out of action by a process analogous to disinfection; thus it becomes clear why promoters and inhibitors exert large effects even though present only in minute concentration.

Now let us turn again simply to the burning of hydrogen, a process of basic importance in the combustion of carbon monoxide and of all hydrocarbon fuels. The initiating step is the break up of a small number of hydrogen molecules into atoms by impact with other molecules travelling at high speed: $H_2 + M \longrightarrow 2H + M$. The hydrogen atoms then react with oxygen molecules giving the *two* active centres OH and O, thus:

must be present to yield the hydrogen atoms or OH radicals (promoters) necessary for the propagating process. I must not continue with this theme, but would merely point out one important result: we learn how the combustion of carbon monoxide may be delayed as a solid fuel burns out, for the hydrogen content of the solid then becomes less and less.

5. 3 The Liberation of Volatile Matter

Anyone who has sat in front of a coal fire is familiar with the fact that the volatile material from coal is released at a much greater rate than the solid is burnt. These two stages—the release of the volatiles and the gasification of the solid residue—become distinctly separated in some combustion appliances, as for example, the travelling grate stoker. The stages are illustrated in Figure 6. If the rate of air supply under the bed is moderate, then an "ignition zone" travels downwards to the foot of the bed (stage 1); this process is accompanied by the liberation of volatiles, the temperature in the zone being merely some 1,000° C. Once the zone has completed its travel, then the combustion of incandescent carbon takes place at the base of the bed (stage 2) and the temperature now approaches 1,500 °C. (The only source of hydrogen during this second stage is from the moisture present in the combustion air, all volatile material

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The following processes ensue ultimately giving rise to water as the stable end-product:

$$\left.\begin{array}{l} H + O_2 \rightarrow HO + O \\ O + H_2 \rightarrow HO + H \end{array}\right\} \text{Multiplication of chains (Branching)}$$

$$\left.\begin{array}{l} HO + H_2 \rightarrow H_2O + H \\ H + O_2 + M \rightarrow HO_2 + M \\ HO_2 + H_2 \rightarrow HO + H_2O \end{array}\right\} \text{Propagation of Chains}$$

$$H + OH \rightarrow H_2O \qquad \text{Breaking of Chains}$$

The stages in the burning of carbon monoxide are similar; for as is well known, the dry gas cannot burn, the reason being that some other agency

containing hydrogen having been previously devolatized. It is possible, therefore, that the partition of the oxygen between the $C \longrightarrow CO$ and

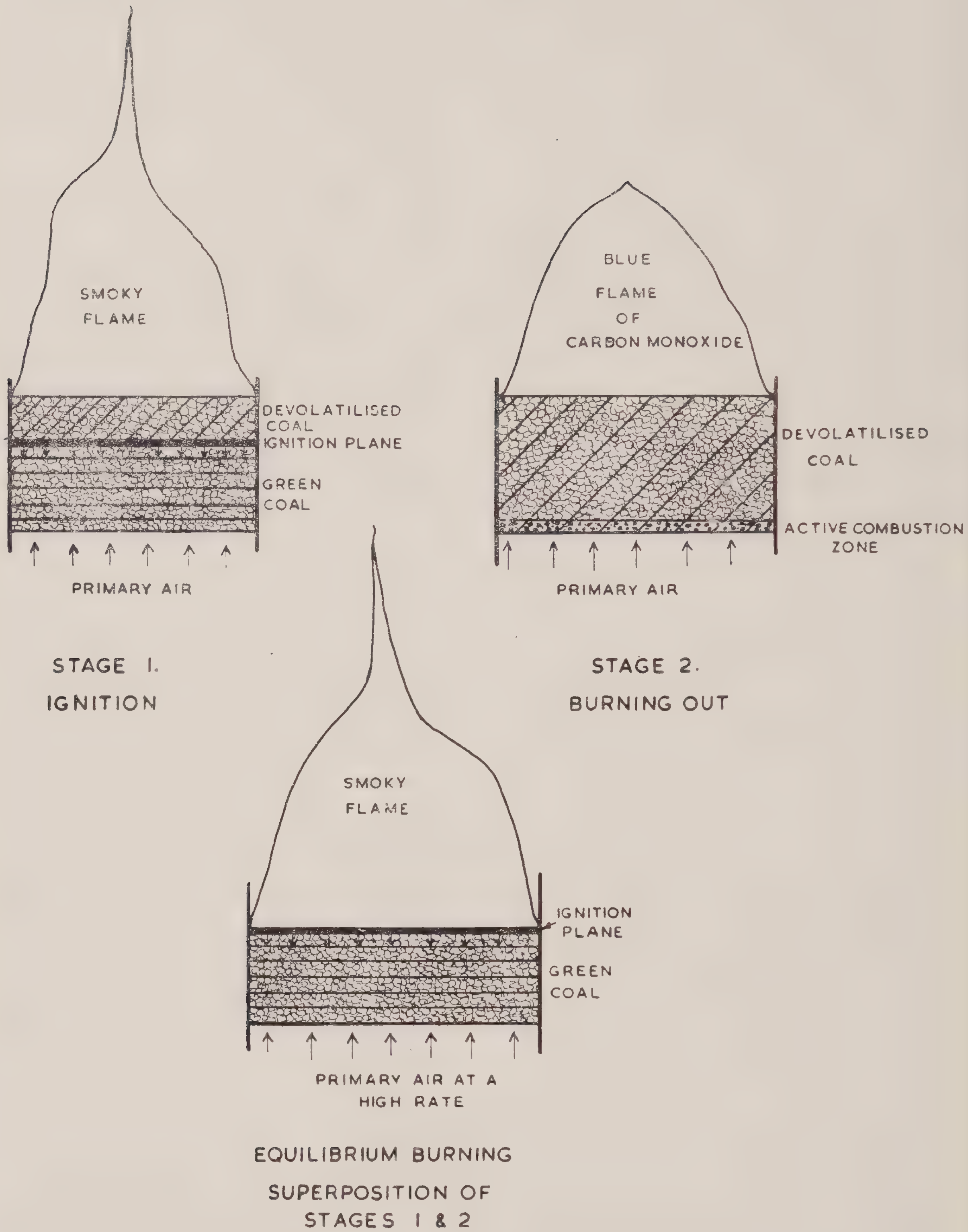


Fig. 6. Stages in the burning of coal

the $CO \longrightarrow CO_2$ reactions depends critically on whether there are sufficient of the hydrogen containing chain carriers to propagate the $CO \longrightarrow CO_2$ reaction; and in view of the fact to which I have already referred that the heat release in the $CO \longrightarrow CO_2$ reaction is about $2\frac{1}{2}$ times as great in the $C \longrightarrow CO$ reaction, the exact partition of the oxygen is of major importance.) By suitably increasing the rate of air supply both stages can be made to occur simultaneously at the top of the bed (stage 3); this is known as equilibrium burning and its attainment is of importance both in relation to the liberation of volatiles and also volatile mineral constituents.

The idea that elementary atoms and molecular fragments, such as those already given in relation to the combustion of hydrogen and oxygen, play an important part in flame reactions generally is now widely accepted. For example, the green tinge in flames is due to an emission of light from C_2 molecules, and the violet colour is due to CH molecules. It had been suggested that soot in flames is attributable to large carbon aggregates formed from C_2 units; but light has recently been thrown on the problem within the B.C.U.R.A. by observing the effect of the presence of inert gases, e.g. carbon dioxide and nitrogen in the combustion gases over burning beds of coal. These gases are components of flue gas and if the latter be recirculated with the air supply to the fuel bed, a reduction in smoke formation is observable. Further, it has been shown that these gases probably exert their influence by inducing the recombination of hydrogen atoms in the flame; and it seems likely, therefore, that hydrogen atoms also play an important part in smoke formation. Briefly, a hydrogen atom can strip another such atom from a hydrocarbon molecule, leaving a reactive residue which reacts further with other hydrocarbon molecules forming a larger composite structure. This material is then attacked by another hydrogen atom: these processes, known as dehydrogenation and polymerization, repeat themselves until the whole of the hydrogen is removed and solid carbon is formed.

Time does not permit me to extend this discussion into such fields as the parts played by volatiles in the formation of coke; it will be apparent, however, that this subject is closely linked with our growing knowledge of the nature of volatile material in relation to pore structure and the part played by rate of heating, etc.

6. SCIENTIFIC STUDY OF SMOKE AND FOG

6. 1 Airborne Refuse

All fuel contains inert material and to whatever purpose our coal supplies are put, their use entails the disposal of some 20×10^6 tons of ash per annum. I will confine discussion of the problem to the waste products of direct interest to your Society, referring later to the role of sulphur. The following airborne materials call for consideration: (*a*) grit, or those small particles of ash carried from the appliance by flue gases (chiefly greater than about 10^{-3} cm. in diameter); (*b*) fume, by which I mean minute particles resulting from the condensation of those materials (alkali metals, etc.) volatilized during the burning of the fuel (chiefly of the order of 10^{-6} cm. in diameter); and (*c*) unburnt particles, arising particularly from incomplete combustion of volatiles.

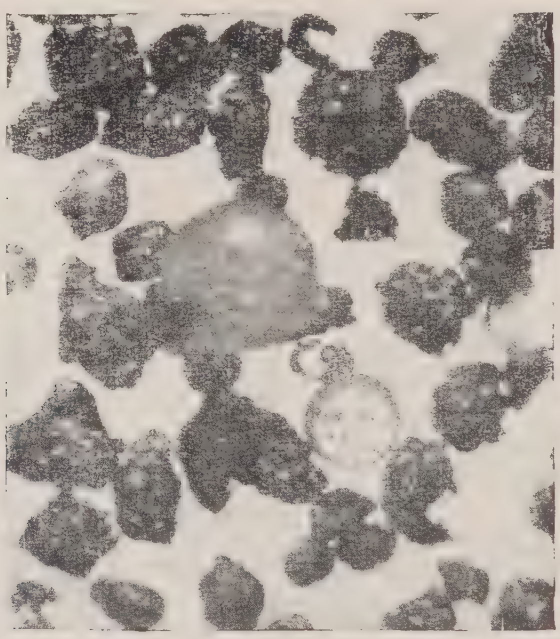
6. 2 Grit

The appearance under the microscope of typical grits is shown in Figure 7; the finest particles referred to under (*b*) as fume are not visible, indeed, they are beyond the range of the light microscope. If present in the material illustrated, they are adhering to larger particles.

The behaviour of grit particles in the air is largely a function of their size; they are all liable to remain airborne for a considerable time. A small grit particle discharged from a chimney 300 ft. high may travel a mile before reaching the ground. Much depends on atmospheric conditions and the lift of the hot gases from the stack will tend to increase the range;

Pulverised fuel grits passing 200 *mesh screen* (*less than* 76μ). *Magnification* × 79.

Pulverised fuel grits retained on 200 *mesh screen* (*greater than* 76μ) *Magnification* × 79.



Typical pulverised fuel grits with high carbon content. All particles greater than 53μ. *Magnification* × 79.

Fig. 7. Typical grits with high carbon content. (J. H. Hellyer and J. C. Cleaves). Society of Chemical Industry Conference on "Dust in Industry," Leeds University, September, 1948

generally, however, greater weight of the grit is deposited near the point of origin, and it may form a carpet sufficient adversely to affect agriculture.

The removal of most of the grit does not present an insuperable difficulty in large plant. Ameliorative action starts in the combustion chamber by suitable control of the aerodynamics; thus in certain pulverized fuel furnaces the combustion gases are directed against slag pits on the surface of which ash particles collect, and in a cyclone furnace, to which I shall refer later, a rotary motion applied to the gases tends to throw the particles to the furnace wall. After leaving the furnace, the gases may be cleaned by passing through cyclones, and greater cleaning still can be produced by electrostatic precipitation, but the cost is high.

Much remains to be done before 100 per cent. cleaning of the gases can be envisaged. The B.C.U.R.A. is at present engaged in providing a reliable yard-stick for estimating the efficiency of plant; indeed, a small portable test instrument has been produced which can completely extract the dust from a gas sample. It is also engaged in investigating an entirely novel method of gas cleaning, but ultimate success of this will depend upon intense scientific effort.

6. 3 Fume

Minute particles of fume remain air-borne very much longer than grit. With a diameter of the order of 10^{-6} cm. they bear the relation to grit in size of a pinhead to an office desk (or of two men to the entire population of the world). Their total weight is merely a small but unknown fraction of that of the grit; the number of individual particles, however, is very large and if they comprised only one-millionth part of the whole material, they would compose 1,000 times as many particles as those of the grit. It is also known from the work of Whytlaw-Gray that when particles of fume collide they invariably adhere, but when the so-called aerosols then formed are sufficiently dilute, they persist for a considerable time and may travel hundreds of miles before being deposited.

It is just these particles which are responsible for fog formation. The mere cooling of air below its saturation temperature will not result in the deposition of water droplets providing the air is first carefully cleaned; if hygroscopic particles are introduced into supersaturated air, however, moisture will immediately condense on them and the resultant drops grow rapidly. One of two things may happen: if there are few particles, the drops will grow to large size and fall out of the gas as rain; if there are many particles, the amount of water available may be too little for the drops to grow to an appreciable size, and they will remain in suspension as fog.

Hygroscopic particles in the atmosphere are provided by salt resulting from either the evaporation of sea spray, or by its discharge from boiler flues. When atmospheric conditions are such that the discharge from boiler stacks is allowed to concentrate instead of being scattered by the wind, and if the air is suitably moist, then fog is likely to occur in industrial areas.

The difficulty in dealing with the problem is obvious; after all, a single fine grit particle weighing perhaps 5 x 10^{-9} of a gram falling on the washing is not going to cause much damage, but the same weight of material in the form of "fume" particles could, under suitable atmospheric conditions, result in the deposition of 1,000 million drops of dilute sulphuric acid, each as large as a grit particle. So we see that it is the finest particles and those which are most difficult to prevent or even detect, which cause most damage.

6. 4 Smoke

The problems I have just discussed are primarily connected with large scale plant. There remains the problem of smoke, which is, or should be, chiefly concerned with small domestic appliances. Smoke is the enemy of efficiency as well as of the clear atmosphere, and large well-equipped plant should not produce it. On the domestic

hearth, where coals are burned, the problem is more difficult.

Studies of the chemical composition of fuel smokes has shown the presence of carbon, hydrogen, tar and mineral matter: domestic smokes tend to contain more tar and less carbon, while those from industrial appliances contain rather more carbon, a certain quantity of ash particles and rather less tar. Recent studies of the B.C.U.R.A. have shown that even in the combustion of tar alone, it is possible to produce quite a variety of different types of smoke which vary in the proportions of tar and carbon they contain. The suspended material ranges from simple liquid droplets, to highly complex chain-like solid agglomerates and relatively tar-free carbon particles. Carbon blacks or "soots" form through the process of coagulation, studied by Whytlaw-Gray; and where ash constituents are present the smoke may be in the form of irregular shaped particles or as "cenospheres." There is probably similarity between the way in which both smoke and fog form.

The prevention of smoke is receiving urgent attention in several places, including our own laboratories. There is no doubt that the intimate mixing of air with the combustible volatile matter in correct proportion and the maintenance of sufficiently high temperature reduces smoke considerably; these matters are receiving quantitative treatment.

One of the major difficulties is that of measurement. The methods which have been used hitherto are based on optical or gravimetric measurement or a combination of the two. Optical methods have involved visual estimates or preferably photoelectric cell measurements of the opacity of smoke. Gravimetric methods involve assessing the weight of the dispersed phase per unit volume of flue gas. Effort within the B.C.U.R.A. has been directed to (*a*) developing an optical instrument which automatically records the optical density of smoke, and (*b*) adapting the principle of thermal precipitation.

7. THE PROBLEM OF SULPHUR

Sulphur and fire have been associated since earliest times; indeed, for long, sulphur was regarded as the principle of fire. Nature, by arranging this close association between sulphur and all mineral fuels has presented mankind with some of his biggest technical problems. One problem, pollution of the atmosphere by sulphur dioxide and of mists and rain by sulphuric acid, is only too familiar to members of your Society. But other problems, comprising the effects of sulphur compounds upon materials undergoing various forms of heat treatment, are of equal concern to a great many branches of industry, and intensive scientific effort is being devoted to them.

It should not be thought that sulphur pollution arises only when coal is the fuel; coke, gas and oil all contain sulphur compounds which are difficult to remove. It is true that coal usually contains a somewhat higher percentage of sulphur than other fuels, but not all of this is released during combustion; some remains in the ash.

Sulphur in coal occurs in two forms: in the associated mineral matter mainly as pyrites or iron sulphide, and in organic form as part of the coal substance. British coals may contain up to 6 or 7 per cent. of total sulphur, but usually less than 4 per cent. is present. Coal washing processes, the primary purpose of which is to eliminate mineral matter, naturally remove a corresponding proportion of the sulphur content, but they do not reduce the organic sulphur; its removal can be partly achieved by heating the fuel in certain gases (e.g. ammonia or hydrogen) but such processes are unlikely to lend themselves to general application.

When coal is carbonized, as much as 60 per cent. of the sulphur content remains in the coke; the remainder appears in the tar, gas and other volatile products. The removal of sulphuretted hydrogen from towns gas is effected with extreme efficiency, but it has not been uncommon in the past for 30 grains or more of organic sulphur to

remain in every 100 cu. ft. of gas, owing to the much greater difficulty experienced in removing it. The position has improved greatly in recent years, however, and in best practice to-day the content of organic sulphur is reduced to, say, 5-10 grains per hundred cu. ft.; the general adoption of this standard may be slow on account of the additional installations necessary.

Let us turn to the generation of electricity; admittedly the production of sulphurous vapours is thereby concentrated in a small number of large units and their economic removal facilitated, but the washing of sulphur dioxide from flue gases at large power stations itself presents great difficulties and is only practised to a limited extent. The sulphur volatilized during the combustion of fuel first appears as sulphur dioxide. Although this gas is itself obnoxious and in close and airless conditions can be dangerous, it is normally readily dispersed by winds and a considerable proportion probably departs overseas. If, however, water droplets are present in the flue gas or atmosphere—and this, as I have already indicated, depends ultimately upon the number of condensation nuclei which may themselves result from volatilization of mineral matter during combustion—the sulphur dioxide readily dissolves and once in solution is readily oxidized to sulphuric acid.

There seems to be no simple immediate solution to the sulphur pollution problem, and in practice the best compromise under given conditions has to be sought; this is equally true of the sulphur problems of industry. One of the most serious has been the deposits on the water tubes of steam boilers, chiefly in power stations; in these deposits the predominant bonding material is sulphuric acid. Corrosion, by sulphuric acid in the flue gases, of the air pre-heaters is another serious problem in steam-raising plant. In these instances, sulphuric acid is formed from sulphur dioxide, not by the mechanism mentioned earlier, but by direct oxidation involving oxygen atoms. A few other examples of industrial sulphur problems may be singled out for mention. Excessive sulphur in blast-furnace coke seriously reduces the quality of the pig-iron produced. Corresponding difficulties are experienced in the melting and annealing of glassware, an undesired surface "bloom" being one of the results. Sulphurous gases give rise to somewhat similar troubles in the glazing of pottery and tiles, and in the process of steel heat-treatment their presence accelerates scaling.

As an illustration of scientific work into problems arising from the presence of sulphur in fuels, I will refer briefly to work initiated by Professor J. W. Cobb at the University of Leeds in the 1930's, and concerned with the scaling of steels in furnace atmospheres; the formation of such scales is not only a "nuisance" but very costly to the iron and steel industry. Steels were subjected at suitable temperatures to varying typical atmospheres and the dominating importance of SO_2 in small concentrations revealed. Figure 8 is a microphotograph obtained by my former Leeds colleague, now Professor A. Preece, showing on the left-hand side the oxide scale, with an inner layer of iron oxide-iron sulphide "eutectic." The mechanism of scale formation under these conditions consists in the solution of iron in the molten sulphide phase at the metal interface and the formation of iron oxide when the molten phase meets the outer oxide layer; the presence of the oxide-sulphide eutectic causes intense inter-crystalline penetration into the steel.

I should refer also to the positive side of the sulphur problem; sulphur recovered by the gas industry is used for the manufacture of sulphuric acid and helps to reduce our demands upon sulphur imported from America and Italy. There is scope for a corresponding recovery elsewhere, particularly from the large quantities of sulphur (in the form of gaseous hydrogen sulphide) produced in the coke oven industry, which up to now have frequently been burnt with the coke-oven gas.

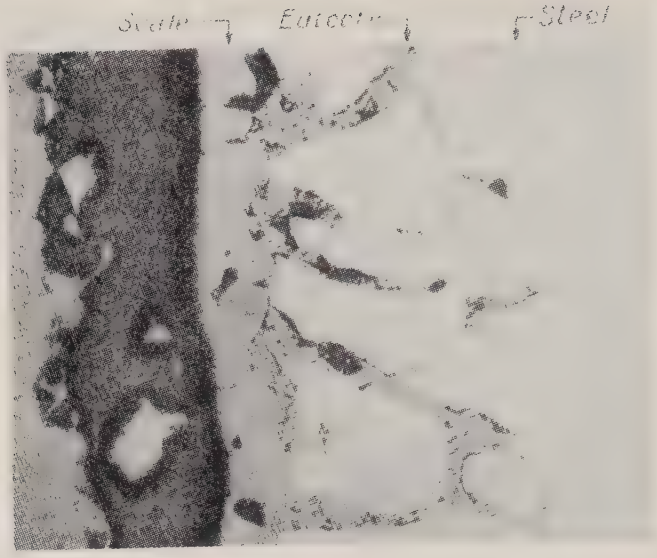


Fig. 8. The influence of sulphur on the scaling of steels. (A. Preece, E. Simister and J. W. Cobb). The Iron and Steel Institute, Special Report No. 24, Section III, 1939. p. 32

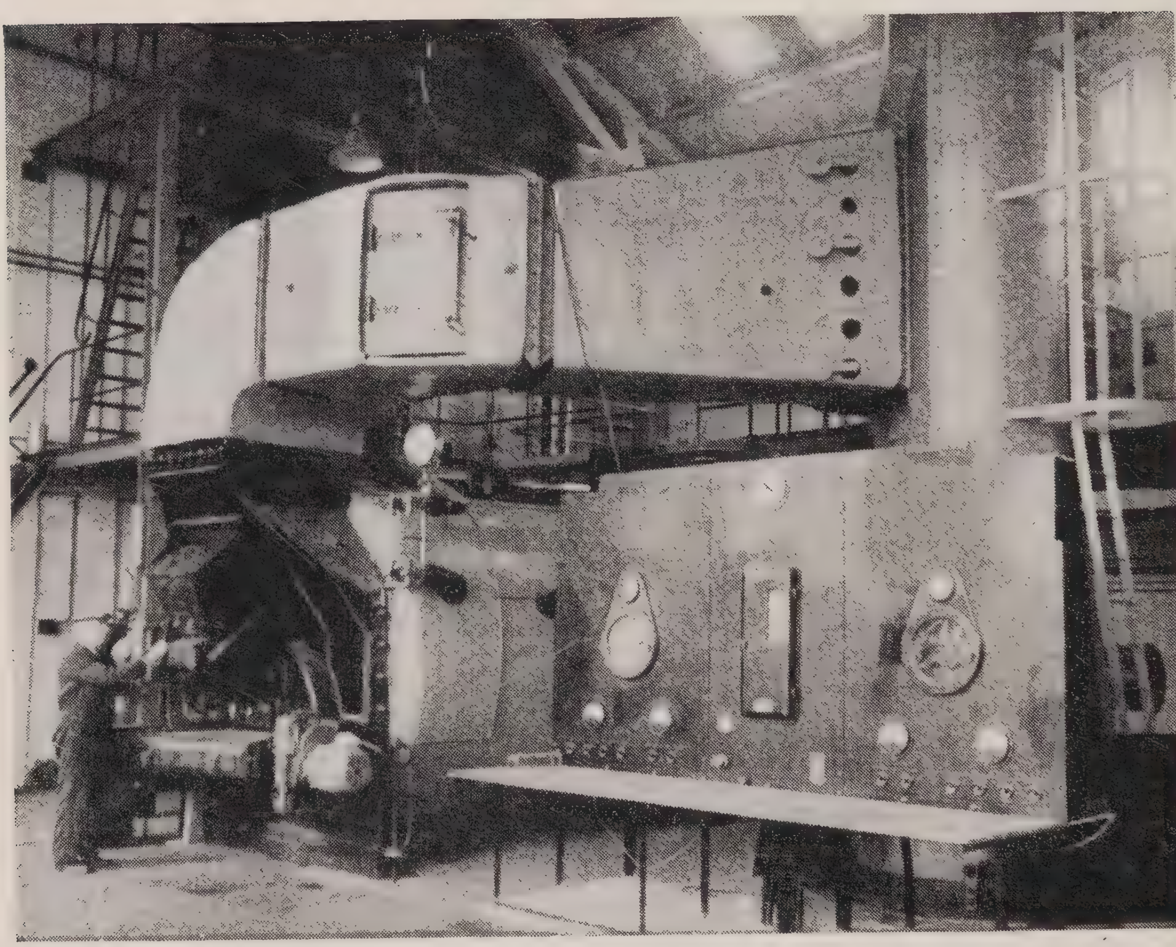


Fig. 9. Experimental boiler installation (B.C.U.R.A.)

8. THE INDUSTRIAL USES OF COAL

Time will not allow my covering this large field too generally; I therefore propose to confine myself to one or two "high spots" to which my Association is devoting special attention.

8. 1 Steam Raising—Shell Boilers

The shell boiler, e.g. of the Lancashire and Economic type, is by far the commonest steam-raising unit in industry. For many years stoking operations were manual and suitable grades of coal for these manual operations were relatively cheap and easy to obtain. So long as steam output equalled requirements, thermal efficiency was not regarded as very important; the economy of the process was not, therefore, studied in detail. The current tendency towards the replacement of man by machine, however, led to the development of mechanized firing appliances; and as far back as 1850, for instance, a French engineer, Juches, devised a chain-grate stoker. It is interesting to note that one of the advantages he claimed for this mechanical stoker was reduction in smoke emission. The adoption of mechanical stoking, however, did not begin in earnest until nearly the end of the nineteenth century; and among the potent factors for its adoption was undoubtedly the increasing call for larger boiler units and the impracticability of handling large numbers of boiler operators. In developing the present type of machine, the engineer has tried in several instances to simulate hand-firing; but other conceptions as, for example, the under-feed stoker and pulverized fuel equipment have been comparatively novel.

It is impossible to overstate the importance in steam raising practice of the changes in the qualities of available coal occurring over the last few decades. This is not the only factor necessitating current enquiries to steam raising practice, but it is an important one. For a century we have creamed our coal resources, our seams are now tending to get thinner, distances of underground transport have vastly increased, working conditions have called for more mechanization, and altogether our coal output tends to be smaller in particle size and higher in ash and moisture. Moreover the clamour for more coal cleaning—justified on most grounds—is being met as fast as possible, but the greater the quantity of high grade coal produced, the greater also is the quantity of low grade material rejected. Improved utilization of coal output, therefore, implies the use of lower grade materials previously rejected. A basic question is, therefore, how can all grades of coal now produced be used to the greatest advantage?

A programme is in hand in the B.C.U.R.A. to find answers to the following questions: How is boiler operation and efficiency affected by (*a*) rank of coal; (*b*) particle size; (*c*) ash content; (*d*) moisture content? Other matters which concern us relate to secondary air admission: are the normal provisions for it adequate; would high secondary air pressure complete combustion at an earlier stage and so reduce smoke emission, and would it raise efficiency; is there a tendency to burn too much coal per square foot of grate area, or could the quantity be increased without loss, and perhaps with gain, in efficiency; what modifications in design of grate might be advantageous?

In order to carry out this extensive programme, B.C.U.R.A. has installed at the Leatherhead Research Station a full-scale Economic boiler (Figure 9). This has a rated output of about 7,000 lb. of steam per hour from and at 212° F. It is fitted with forced and induced draught plant to enable the use of a wide range of experimental conditions, and the design allows for the quick and easy installation of almost any type of stoker. Steam output is condensed and the cooled condensate passes through a weighing tank into storage for further use; and the whole installation is very completely equipped with instruments, the results of trials being examined statistically as well as graphically. While this installation is most directly useful in connection with

shell boiler problems, quite clearly much of the information which we hope to gain will apply also to water tube boilers. The shell type boilers installed in industry to-day are mostly of the Lancashire type, with or without economizers. There does, however, appear to be a move towards the Economic type where a larger heating surface can be accommodated within a smaller space. Mechanized firing of shell type boilers is not as yet universal, but progress has been made and recent applications of the chain grate stoker have demonstrated the value of this appliance when used in shell type boilers.

8. 2 Steam Raising—Water Tube Boilers

The water tube boiler is generally a much larger unit than the shell type boiler and operates at much higher levels of steam pressure and temperature; the essence of its design is that high steam pressures and temperatures are accommodated far more easily in vessels of small diameter. The water tube boiler in all its forms, therefore, consists of a multiplicity of tubes of relatively small diameter, carrying water within them and exposed to heat at the outside. The use of high steam temperatures and pressures is rendered necessary by the fact that the efficiency of heat engines depends on the temperature and pressure of the inlet steam. The water tube boiler, therefore, is to be found mainly in power stations, large marine propulsion units, and in large industrial undertakings, especially those in which the power demand is heavy in relation to process steam demand. Where steam is required mainly for its heating value, high steam pressure is of no advantage, and hence the more simple shell type boiler is used.

An exception here may be found in the steam locomotive; in spite of the fact that the steam is used mainly for driving the engine, moderate pressures of up to 300 lb./sq. in. generated in shell type boilers are still universally adopted, indeed, water tube boilers have been tried in this field but with little success.

The water tube boiler has developed from the "land type" original of Babcock & Wilcox through the stages of the "marine type" to the present-day monsters evaporating half-a-million or more lbs. of water per hour, at pressures well in excess of 1,000 lb./sq. in. Variants of the water tube boiler include the adoption of forced circulation and of very high superheat, using the superheated steam as the evaporative medium. Trends in firing seem to be away from the fuel bed towards the burning of coal in suspension; pulverized fuel, in fact, is being used on an increasing scale and the country awaits with interest, judgment on the new cyclone burners (using coal fines) shortly to be installed at Barking.

As already mentioned, one of the most serious problems encountered in water tube boilers in recent years has been the forming of deposits on the tubes (Figure 10). These interfere with heat transfer, make it necessary to increase fan power in order to maintain draught, and eventually necessitate taking the boiler out of service for cleaning. Referring to this problem four years ago, Sir Johnstone Wright disclosed that it was necessary in 1938 to reduce the rating of a number of power station plants by as much as 15 per cent. from this cause alone. This problem is one on which a considerable amount of work has been carried out by the B.C.U.R.A. in collaboration with the Boiler Availability Committee, representative of the Water Tube Boiler Makers' Association, the British Electricity Authority, the Fuel Research Station, and the B.C.U.R.A. Scientific studies have established that these external boiler deposits originate in the inorganic substances, sulphur, phosphorus and alkali metals present in the coal used. Temperatures in the fuel bed under a boiler are normally very high, and may be anything up to 3,000° F. Under such conditions alkaline substances are released either as vapour or as finely divided particles which pass with the combustion gases over the relatively cool water tube surface and condense and build up upon them. The deposits formed are extremely hard and difficult

Fig. 10. Bonded deposit bridging superheater tubes. Crown copyright. Reproduced by permission of the Controller of H.M. Stationery Office

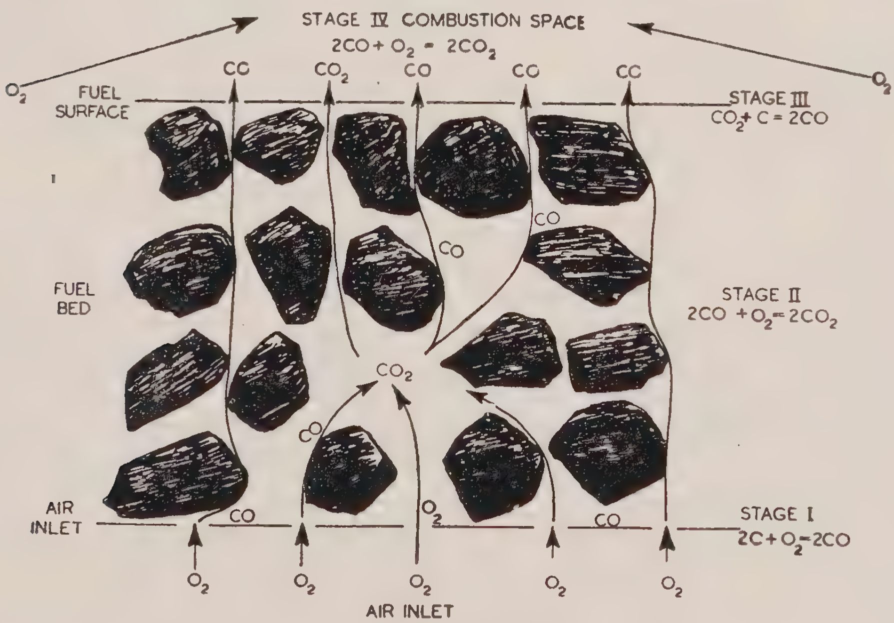


Fig. 11. Diagramatic representation of the sequence of gas reactions in a fuel bed

to remove. Analysis has shown that they are principally sulphates and acid sulphates of sodium and potassium. In some cases they may contain phosphates and are then specially difficult to remove since they are insoluble in water. The excessive hardness is attributable to the sulphur oxides in the flue gases, present to the extent of 0.1 to 0.2 per cent. by volume. The principal part of the sulphur from the coal passes up the stack in the form of SO_2 and appears to have little effect on the boiler, but some is oxidized to sulphur trioxide. This combines with water vapour to form sulphuric acid, condenses out in the cooler zones of the boiler and reacts with the deposited alkalis which it bonds into hard masses. Even very small amounts of sulphuric acid considerably raise the minimum temperature at which condensation occurs (i.e. the dewpoint). When, therefore, the flue gases carrying these small contents of sulphuric acid pass through an air heater, even at a temperature as high as 400° F., condensation occurs, followed by corrosion and all its undesirable consequences.

In the laboratory, work has been undertaken in search of palliatives. It has been found that when certain smokes are introduced into the combustion gases they inhibit the release of sulphur trioxide. Exactly how this occurs is not completely understood ; it may be that particles suspended in the gas interfere with oxidation of the sulphur dioxide. It may, on the other hand, be that they act as absorbents for sulphuric acid, and possibly both these effects occur. This observation is being followed up actively at various power stations ; it seems very possible, also, that the palliative action of smokes may be simulated in practice by the introduction of fly ash achieved by associating a pulverized fuel unit with the main chain grate firing arrangement. Alternatively, means may be found for conducting the firing process on a mechanical grate in such a way that lower temperatures occur in the fuel bed with less volatilization of the inorganic materials in the coal ; experiments to this end are now being conducted by recirculating part of the flue gases through the fuel bed.

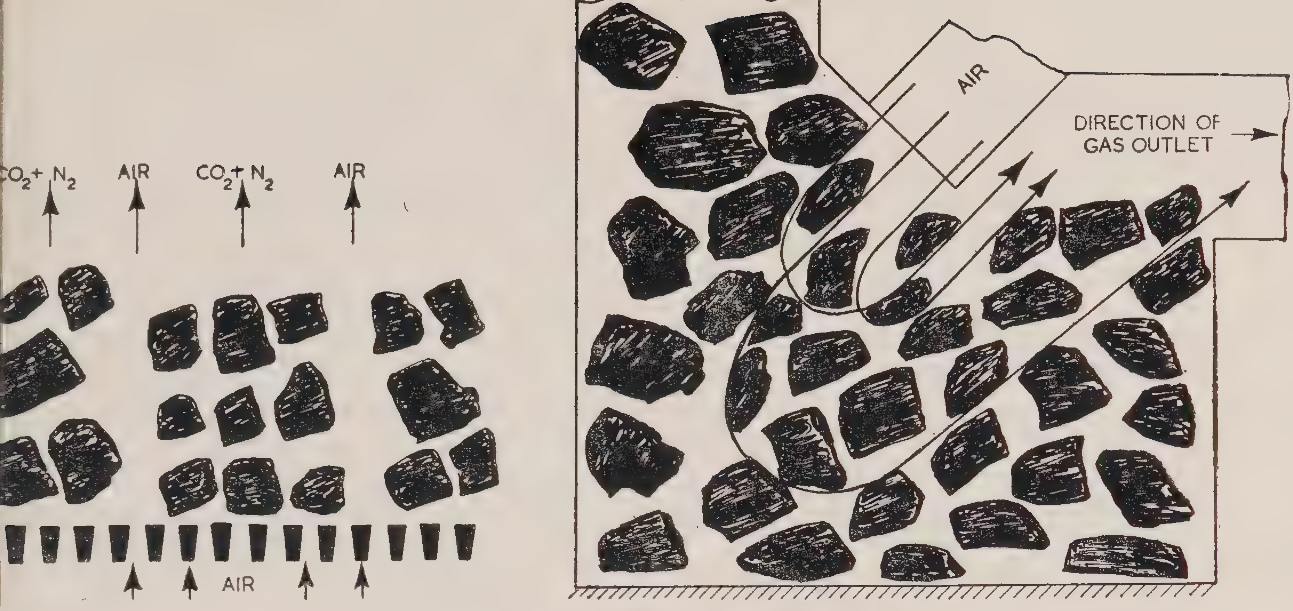
8. 3 Industrial Furnaces

The classification "Industrial Furnaces" includes furnaces for steelmaking, its reheating and heat treatment, the working of non-ferrous metals, and the manufacture of ceramics. In the past attention has been focused upon designing the furnace to carry out the job ; but modern requirements for reproducibility of product, and—more recently perhaps—fuel economy, have demanded a more scientific approach to furnace design.

Let us consider, for example, the steel industry ; and in particular the production of high carbon steels for toolmaking, wire products and armaments. It is important that carbon, intended to be in the steel in certain proportions, should not be removed during processing. The presence of oxidizing gases (e.g. O_2, CO_2, H_2O) in the furnace atmosphere in which the steel is being heated tend to remove the carbon from the place where it is most often needed, namely on the surface.

When coal is burned completely and smokelessly, these oxidizing gases are usually present to an extent such that the steel decarburizes, more or less seriously. In the past, attempts were made to avoid this by deliberately ensuring incomplete combustion of the fuel, and while some oxidizing gases were necessarily present, their deleterious effect was to some extent counter-balanced by the presence of reducing gases, for example, carbon monoxide and methane. The result of this partial correction, so far as coal-fired furnaces were concerned, was the production of heavy black smoke.

Recent scientific appraisal of this problem has shown that at a certain temperature, there is a critical concentration of the various gases, depending on the analysis of the steel, beyond which the steel may decarburize and below which it might tend actually to take up carbon. The coal-fired furnace, quite apart from its tendency to produce smoke, suffered from lack of controllability over a period of time ; and even



(a) (b)

Fig. 12. Comparison between down-jet firing and normal grate firing ; (a) Gas flow in grate firing with a thin bed ; (b) Gas flow in down-jet combustion

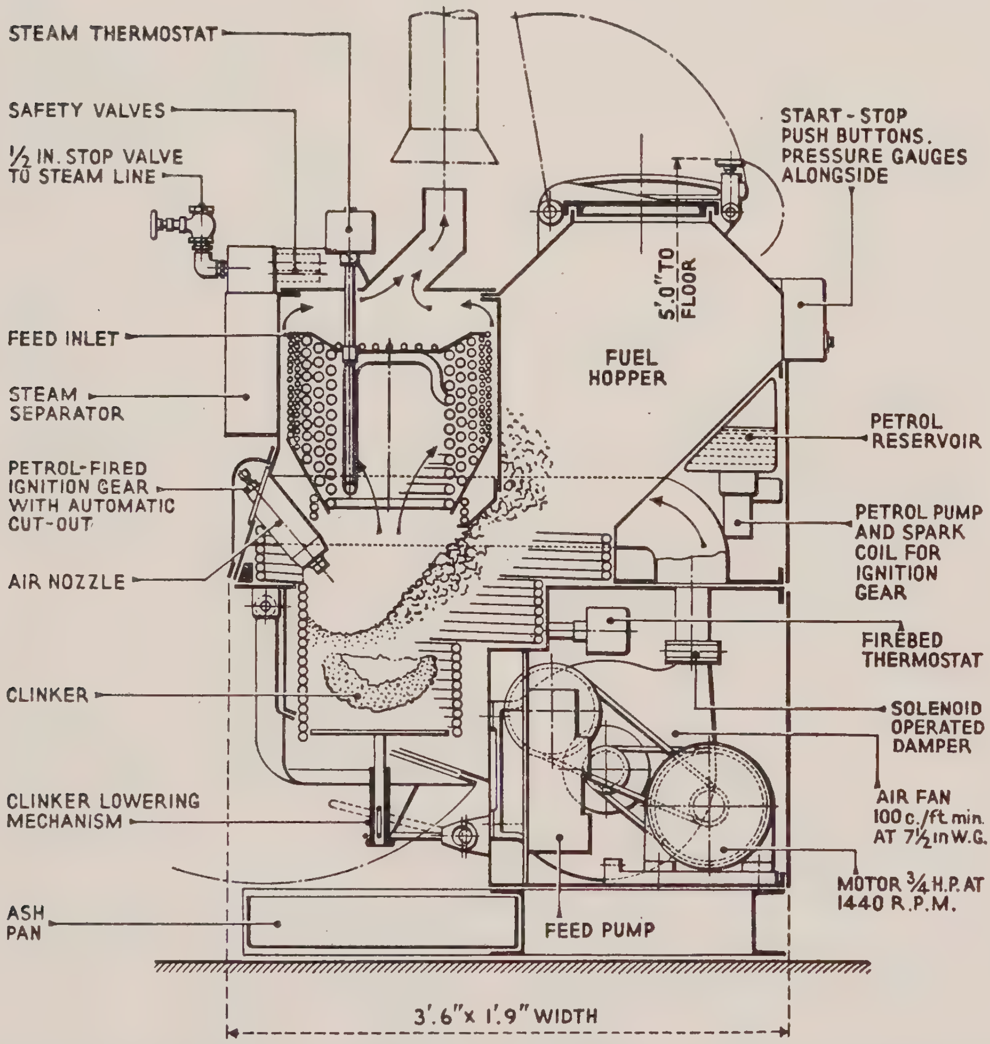


Fig. 13. B.C.U.R.A. portable down-jet steam generator. Reprinted by permission from the Journal of the Institute of Fuel, 25 ; 23, Jan. 1950

if an ideal atmosphere were obtained, attention to fire grates would mean inevitable upset of the necessary conditions. A movement has, therefore, taken place towards the gas-fired furnace, which is more controllable in every way, and is operated at a considerably higher thermal efficiency than its cruder predecessor. Sheffield to-day bears witness of this movement. It should also be mentioned that the use of science in improving the heat treatment of steels has resulted in rapid progress in allied channels ; indeed, the modern processes of bright hardening, bright annealing, " gas carburizing " and " gas pickling " are all the result of scientific thought rather than of the art of the technician.

Thermal insulation of furnaces and a recognition of logical sequence of furnace operation have made their contribution to fuel economy. In the Potteries, for example, the continuous tunnel kiln, heated by gas or electricity, is rapidly displacing older intermittent kilns which burned raw coal. A significant reduction of smoke emission has already been noted.

Progress in certain processes is now demanding the use of high grade super-refractories ; for while many of those available are satisfactory in service, there are certain applications to which they are not suited. Resistance to molten ash is one of these and the mixed oxide known as Zircon promises certain advantages in this direction. The development of zircon refractories is under investigation by the B.C.U.R.A. and the perfection of a manufacturing process might well mean that a new material may become available, adequate for the higher temperatures now being encountered in industry.

8. 4 Down-Jet Principle

I should now like to refer briefly to a recent development of the B.C.U.R.A., termed the down-jet burner. The chemical reactions proceeding during the oxidation of fuel in a fairly deep bed are illustrated in Figure 11. As already outlined, the primary combustion product of oxidation is carbon monoxide ; the completion of its combustion to CO_2 is effected in the voids if adequate oxygen is available ; but if the bed be deep, the CO_2 is afterwards reduced to CO by further contact with incandescent fuel. Deep fuel beds, therefore, necessarily function as gas-producers ; in consequence the gases leaving the bed have to be re-mixed with air (secondary air) to ensure their complete combustion. The problem can be overcome by providing a sufficiently thin bed ; there is then, however, considerable risk of the escape of unconsumed air by channelling, as illustrated in Figure 12*a*.

By employing the down-jet principle, the fuel, instead of being carried on a normal grate, is supported on a solid hearth or clinker-removal device which is remote from the supply of air (Figure 12*b*). The combustion air, instead of being fed through the grate, is fed through one or more nozzles located above the fuel bed and out of contact with it. As a result, the bed may be quite deep without ill effect, for the degree of chemical interaction can be governed very precisely by controlling the air jet. No separate adjustments of primary and secondary air intake are required to control the composition of the flue gases ; and the combustion chamber can be quite small and there are no fire bars to get burnt.

In a coke-fired down-jet furnace most grades can be used ; the fuel is contained in a hopper with a sealed lid as in the portable down-jet steam generator, illustrated in Figure 13. It falls from this hopper under a " feed edge " to form a free surface at the angle of repose, the burning surface. The ash sinks into the bed as a molten slag, solidifying to a dense clinker pad containing little or no combustible matter. For one-shift operation of up to ten hours, the furnace can be so designed that it requires no attention at all. Coal for use in this type of furnace must be of the kind which will agglutinate and form a coke ; fortunately 40 per cent. of British coal reserves, in addition to those classified as good coking coals, satisfy this requirement, and combustion is smokeless. While in the case of coal some

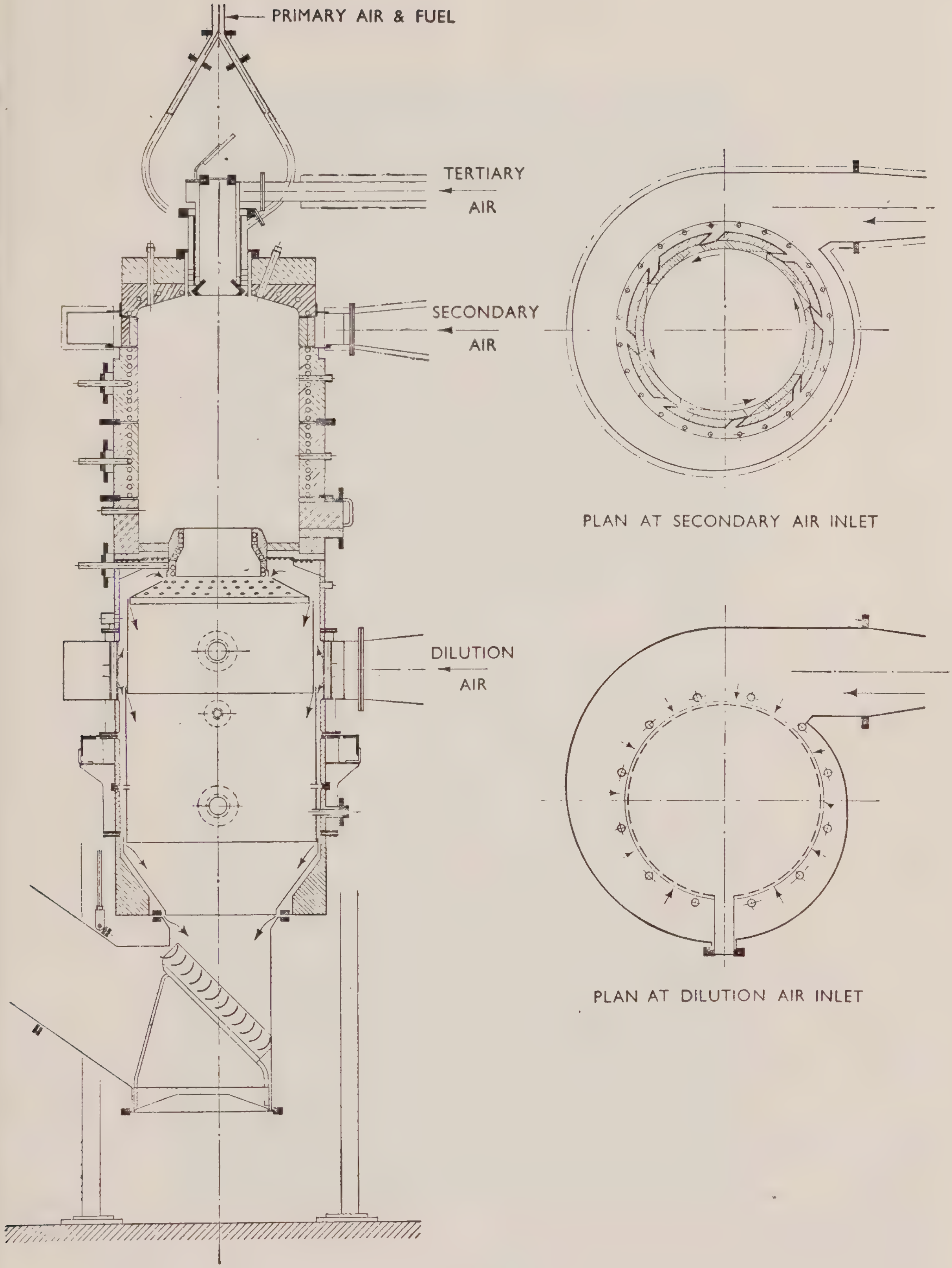


Fig. 14. Sectional arrangement of B.C.U.R.A. experimental combustion chamber. Reprinted by permission from the Journal of the Institute of Metals, 296 ; 17 ; June, 1950

industrial development is still necessary a number of units burning coke have already been successfully installed in industry. I have not time to enumerate other advantages of the method, and it is hoped that in due course it will find wide application.

9. SOLID FUEL FIRING FOR GAS TURBINES

Considerable time would be required to discuss the methods of pulverized fuel-burning developed in recent years now being used to an increasing extent. Methods for using fine coals have been encouraged by several factors, one being the very notable increase in the quantities now available as a direct result of mining developments. One problem which should be mentioned in passing is that of assessing the suitability of small coals for grinding to the necessary fineness for pulverized fuel practice, and a programme concerned with this problem, " grindability," is in progress in the B.C.U.R.A. Laboratories.

A relatively new and important development is concerned with the efficient use of small coal as a source of gaseous energy for gas turbines. Incidentally, some American workers have been actively engaged on a parallel problem in connection with steam locomotives and already a pilot locomotive based on the principle is on trial.

Under an arrangement with the Department of Scientific and Industrial Research, the B.C.U.R.A. is collaborating with the Fuel Research Station in designing a suitable combustion chamber for use with an open cycle gas turbine. As preheated air is a prerequisite, the use of the down-jet principle was at first envisaged ; it was ultimately decided, however, that a chamber working on the cyclone principle would have wider application. The task is to find a suitable design of chamber in which low grade crushed coal can be burned and the whole of its ash removed from the hot gases before they pass forward to the turbine. An experimental cyclone furnace (Figure 14) has been constructed to burn coal at the rate of about 200 lbs. per hour ; combustion of the coal particles occurs partly in suspension, but mostly on the slag-coated walls to which they adhere. The combustion chamber is mounted over another chamber in which air can be mixed with the combustion gases and any ash particles chilled ; most of the ash, however, is trapped on the walls of the top chamber and removed as slag. The actual combustion chamber comprises only a small part of the complete rig (Figure 15) which includes air blowers, gas fired air preheaters, air dilution fans, cyclones for removing dust from the products of combustion, and apparatus for adjusting the rate of coal feed. The whole rig is carefully instrumented and designed to work at atmospheric pressure ; but the experiments will provide the necessary design data for the construction of a pressure chamber as required for operation with a gas turbine. The work is co-ordinated with the research and development programme on solid fuel fired gas turbines, sponsored by the Ministry of Fuel and Power, and it is hoped that the information gained will be of value not only in the development of gas turbines, but also in the application of the method to the smokeless combustion of low grade fuels generally.

10. DOMESTIC HEATING

The procession of subjects reviewed is almost ended. Lest I be taken to task for having left domestic fuel service to the end of the procession, may I point out that it has in this way been accorded the place of honour.

This purpose of coal utilization probably accounts for the consumption both directly and indirectly of something like 80 million tons per year, of which nearly 40 million tons is used in the raw state. From nearly every point of view, efficiency, atmospheric pollution, etc., the domestic use of coal has in the past been the blackest blot on our escutcheon. The position has improved considerably in recent years, however, and to this due credit must be given to the growth in use of gas, electricity and coke. A century ago, these alternatives to raw coal were not

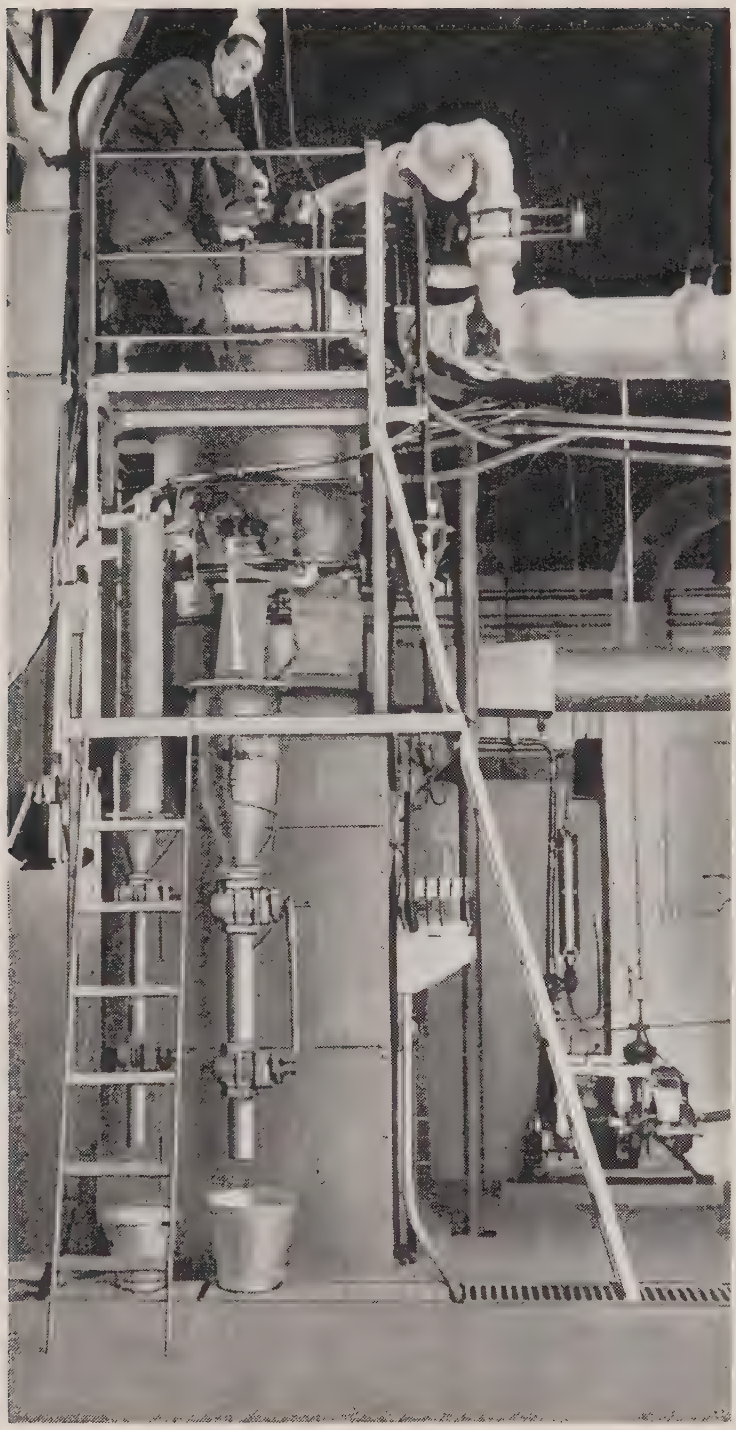


Fig. 15. General view of B.C.U.R.A. experimental combustion chamber

available in any sense as they are to-day. There was an acute awareness at that time of the deficiencies and nuisances associated with domestic coal-burning and there is plenty on record to show that very strenuous efforts were made to grapple with them. A number of interesting ideas were born and put into practice in the form of domestic grates and many of them were far more efficient in every way than the stool-bottom grate of the present day.

You will recall that in the Simon Report the three main lines of development then envisaged towards efficient, convenient and smokeless domestic heating were, briefly : (1) replacement of the bulk of bituminous coal now burnt in raw state by smokeless solid fuels ; (2) increase in use of gas and electricity ; and (3) burning of bituminous coal with higher efficiency and reduced emission of smoke.

During the four years since the Simon Report was presented, production of smokeless fuels has risen but slowly. Leaving on one side the availability of high temperature coke, the principal British company in the low temperature carbonisation industry, namely Coalite and Chemical Products Ltd., is now carbonising on a scale approaching half a million tons of coal per annum ; incidentally, also, in the U.S.A. a new three million dollar plant at Pittsburgh operating the Disco process on a basis of about 300,000 tons of coal per annum has recently been set to work. The National Coal Board is endeavouring to extend considerably its production of smokeless fuels suitable for open and closed domestic stoves, but progress in extending most large-scale plants is hampered seriously by present economic conditions.

Precisely similar difficulties have to be faced in respect to any considerable early extensions of gas and electricity supplies ; progress is good in all the circumstances, but they will take time.

It is obvious, therefore, that course (3), namely to improve the burning of raw coal, is one which must be pursued with all vigour. There is still much to be achieved and the scientist has by no means finished with the problem. Reference may be made to the efforts during recent years in America and in France in the development of closed appliances for burning bituminous coal with much reduced smoke emission. Collaboration with research workers in this field has been maintained by the B.C.U.R.A.

There is little opportunity here to survey the whole field, and I propose to confine attention to some of the work effected in the B.C.U.R.A. A few years back the appliance manufacturers and the coal distributors supported a programme which resulted in a design of open fire (Figure 16) which provided a fairly deep fuel bed, a deep ash receiver and air supply from beneath the floor. Continuous burning is possible by the use of a hood which can be drawn down over the fire at night ; convected heat is brought into the room by circulation of air round the fire back, and the ashpan is sufficient to accumulate ash over six or seven days of continuous burning. This type of appliance was developed at a time when we were looking forward to the post-war programme of building and re-building. It is pleasing, however, that a number of features of this unit have since found their way into standard designs of appliances now on the market, in particular the devices for fire closure and arrangements for convection heating.

Another development in our work began at about the time of the acute fuel shortage early in 1946. This was the " stand-in " fire. It arose directly out of the fire devised by A. F. Dufton and described by him in the Journal of the Royal Institute of British Architects in 1942. The " stand-in " fire, like the Dufton, was in the nature of a renaissance of the Cheminée de Nancy of two centuries earlier. Briefly, it is a fire box with a refractory lining and fitted with a trumpet-shaped top connected to a simple rectangular sleeve which passes up through a horizontal register plate into the chimney. Shapes and dimensions were so designed as to enable easy fitting to the majority of fireplaces in general use, in spite of their great diversity. Our purpose was to

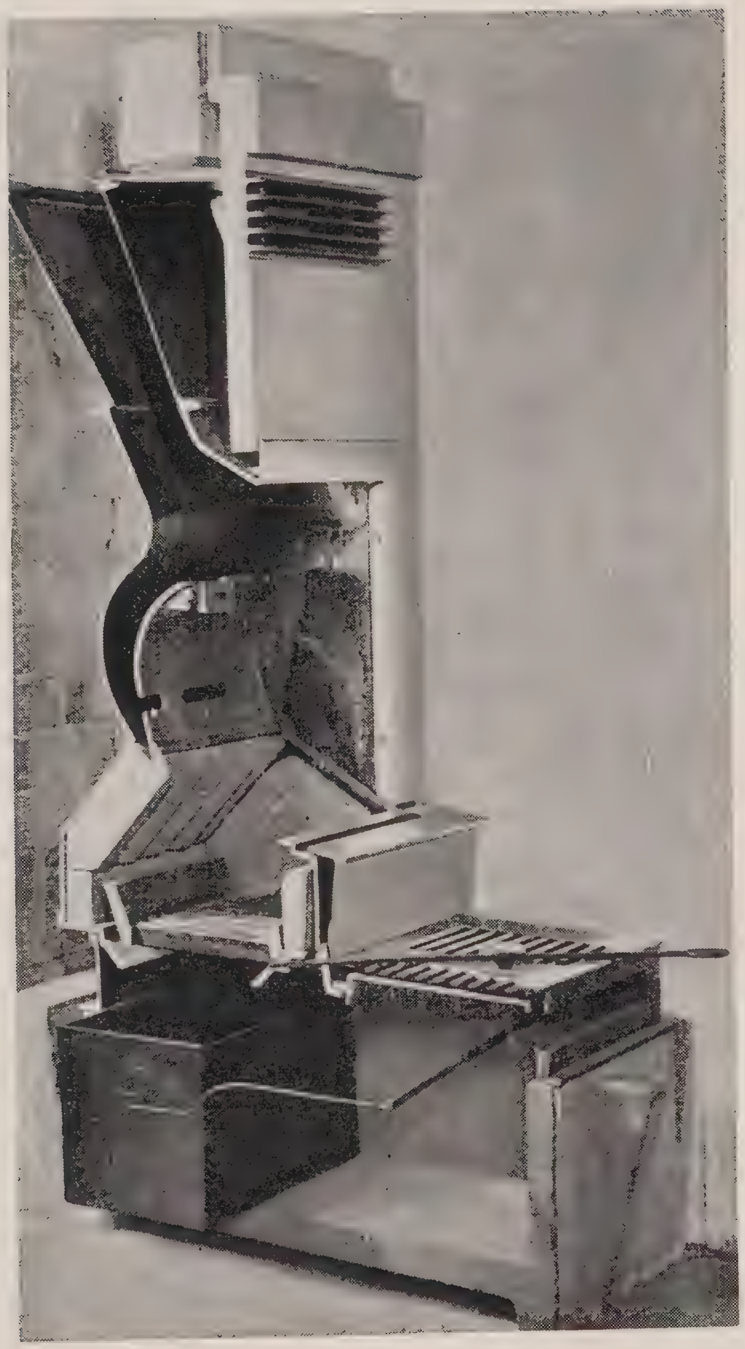


Fig. 16. Section of B.C.U.R.A. open fire (1942-45)

ascertain what principles of design should be followed to provide a simple, cheap, efficient and easily fitted appliance which could be constructed in materials easily available at the time. Tests showed that, taking into account the greatly reduced room ventilation, a fuel utilization efficiency of some 50 per cent. could be obtained in comparison with 25 per cent. given by the usual stool-grate. Moreover, the device was smoke reducing although not smoke eliminating, and we have learned from experience of its use.

In the course of all this work we have developed in the laboratory quite an armoury of testing implements for observing, measuring and recording essential data connected with performance. Such data includes rate of fuel consumption, radiation and convection, temperatures, draught and smoke emission ; techniques are now available to us for studying many new ideas for fire design.

The second line of work which has been followed in domestic appliance studies is concerned with the external factors, namely the control of heat losses from the house through excessive ventilation and by thermal conduction. We ourselves have studied the problem of excessive ventilation and considerable increases in thermal efficiency have been achieved by applying controls.

I should also refer to efforts which have been made towards the co-ordination of appliances in the house. This again has been under study by other research organizations ; our own contribution has been the evolution of the All-Purpose Service Unit, or, more briefly, the "House Engine." This was conceived when the post-war building programme was very much in mind. It is based on the conception that only by planning the fuel services of the house before planning the house itself is it possible to obtain the greatest improvement in efficiency. A complete structural unit was, therefore, developed to incorporate all the services, intending that this should be prefabricated and set up centrally on the housing site ; the house is then built around it. The unit is a steel-framed tower standing from ground to roof level ; in this is a central flue, all the water services and tanks (suitably insulated), electrical services and, at ground level, a single-fire two-way solid fuel appliance giving space heating, water heating and cooking facilities. It also embodies electrical arrangements for "topping-up" the oven and hot plates or for obviating use of the fire during Summer. Long-period tests have shown that a typical annual consumption to be expected for a three-bedroomed house is of the order of three tons of solid fuel and 1,400 units of electricity ; and it should be quite simple to incorporate gas service if required.

11. REFLECTION

There are other fields which I should like to have discussed, particularly complete gasification, which, in the end, may do much to ease many difficulties concerned with the burning of solid fuels ; moreover, complete gasification ought to facilitate utilization of the low grade fines which are imposing increasing problems on our mining industry.

I have, however, related—in fitting commemoration of him we now honour—a story revealing the interlock of science and practice with special reference to the smoke problem which all of us have so much in mind. One is bound now to reflect upon how much ought to have been achieved nationally at the time of the early days of your Movement and while this country was still prosperous. To-day we are all aware of the great and pressing national problems which are, in the main, the outcome of two world wars with consequent loss of the capital reserves built up during the 19th century. This said, there are two sides to any story, and although smoke is one legacy of the industrial revolution, we have to remember the great progress resulting directly from that period, especially in standards of living and knowledge and popular education. There has been, for example, vast growth in scientific knowledge and particularly in its application to such fields as medicine ; so that to-day, notwithstanding other hardships, including smoke, the average

man and woman can look forward to a longer lease of life. Perhaps I may quote here Sir William Beveridge: "There are bound to be acute difficulties of transition . . . but to suppose that the difficulties cannot be overcome, that power of readjustment has deserted the British people, that technical advance has ended or can end, that the British of the future must be permanently poor because they will have spent their fathers' savings, is defeatism without reason and against reason."

I have indicated that many of the problems arising from the industrial revolution have received only partial solution, even with present scientific knowledge. But this knowledge is rapidly advancing and finding increasing application; given, therefore, the conditions of peace and returned prosperity for which we all hope, we may anticipate rapid progress towards the better general welfare of mankind.

Looking back over the years upon efforts made to raise standards in the use of our precious asset, coal, we are conscious of the debt owed to single-minded, courageous pioneers. Many names come to mind, of course; but among them I should just like to refer to another pioneer of your own Society, who is with us here to-day—I refer to our friend, Dr. Rudolf Lessing, whose many-sided contribution to progress is well known.

This Address has been composed at a time of personal pressure, and it would not have been possible without the generous assistance of several of my colleagues within the B.C.U.R.A.; among them I would express thanks to Dr. I. G. C. Dryden, and particularly to Mr. J. B. Reed without whose unfailing assistance my script could not have been prepared in time for your Conference. I should also like to mention the delight of my late colleague, Dr. D. H. Bangham, at the invitation extended to me by your Society; we discussed together the ground I might suitably cover and, knowing how willingly he would have helped me had he survived, I have been the more glad of this opportunity of reviewing much of his work. For scientific progress in the fields I have covered owes much to his labour.

RESPIRATORY DISEASE IN ASSOCIATION WITH ATMOSPHERIC POLLUTION

By Dr. J. S. G. Burnett, M.D., D.P.H.

Medical Officer of Health, County Borough of Preston.

THE respiratory system, being exposed to the external atmosphere, is directly susceptible to the influence of aerial contaminants both organic and inorganic during the whole period of a person's existence. The defensive mechanism of the organs of respiration is therefore continuously engaged in resisting the invasion of pathogenic organisms, in repelling the entrance of particulate matter, and in withstanding the effects of toxic gaseous substances. All of these processes may be operating simultaneously and indeed in combination, as in counteracting the invasion of a gaseous substance adsorbed on a solid particle, whilst the collapse of one bastion of defence may well undermine another resistance process, as can be seen in the supervention of tuberculosis on a lung already weakened by the presence of silica particles.

There is therefore a complex play of factors, extrinsic on the one hand, varying in quantity, quality and duration of application and intrinsic on the other, varying from individual to individual and from time to time in the same person, the results of which will range from no obvious reaction through a non-specific reaction to one specific to the attacking substance.

Inhaled solid particulate matter initially may produce a non-specific catarrhal reaction associated with coughing, sneezing and possibly bronchial spasm, but is known also to produce certain specific pulmonary lesions. The occurrence of silicosis in miners, stone masons and other workers engaged in industrial occupations involving exposure to silica dust in the atmosphere is of course well known and constitutes a specific reaction to a particular irritant. Byssinosis in cotton workers and asbestosis in asbestos workers are other instances of the same phenomenon.

Similarly gaseous compounds present in the atmosphere have produced reactions specific to the particular gas, but these instances again are associated with industrial processes or with warlike activities. A few months ago at an ironworks in the north-east eleven workmen were reported in the press to have died from asphyxiation with carbon monoxide which had leaked into the atmosphere in which they were working. As with the inhalation of particulate matter this specific reaction depends, so far as the extrinsic factor in the problem is concerned, on the nature of the substance, on the intensity of exposure to it and on the duration of exposure, this latter varying from seconds in the case of certain toxic gases to years in the case of certain dusts.

When we leave the results of atmospheric pollution arising from industrial hazard and turn to the effects of general atmospheric pollution, the problem seems to be of a different character and so far as the more acute illnesses are concerned is apparently not one of specific reaction to a single toxic or irritant substance. Two dramatic incidents have occurred abroad in which general atmospheric pollution of high degree has coincided with the occurrence of acute respiratory illness in a large section of the population at risk and death in certain cases.

The Meuse Valley Incident

The first of these incidents occurred in the Meuse Valley of Belgium in 1930, and was the subject of an immediate public inquiry.

A dense fog covered a large part of Belgium between the 1st and 5th December and in the valley of the Meuse temperature inversion appears to have resulted in atmospheric pollutants derived from the industrial and urbanized region around Liège being deposited on that city and the narrow river valley running south-west from it some 18 miles upwards to the village of Huy. Fog conditions grew worse and on the afternoon of the 3rd December respiratory illness began to be reported simultaneously throughout the length of the valley. Several thousand people were affected variously with symptoms of watering of the eyes, sore throat and hoarseness, cough often spasmodic in character, expectoration, difficulty in breathing and pains in the chest of whom several hundreds were seriously ill complaining of respiratory embarrassment and in a fair number of cases symptoms of cardio vascular insufficiency developed. More than 60 persons died on the 4th and 5th December after only a few hours illness but on the 6th the fog cleared and rapid recovery among the sick was the general rule. The village of Engis with a population of 3,500 and where the fog was probably densest had the following experience regarded as fairly typical for the whole region.

Date	*Fog*	*New Illnesses*	*Death*
1st December	+	—	0
2nd December	++	—	0
3rd December	++++	commenced	0
4th December	++++	continued	8
5th December	++	finished	6
6th December	—	—	0

Investigation showed that the aged and those with pre-existing cardio-respiratory disease were particularly affected, though the occurrence of quite severe bronchial asthma in apparently robust people was observed by the investigators.

Post mortem examination was carried out on a number of fatal cases and showed evidence of acute irritation of the respiratory tract.

The picture is one of non-specific irritation of the respiratory passages from the presence in the atmosphere in harmful amounts of a combination of gaseous irritants and solid particles derived from the domestic and industrial chimneys of the region. The conclusion from the investigations carried out was that the main irritant was probably sulphur compounds, that increased penetration even to the lung alveoli could have been achieved by virtue of adsorption of the gases on the solid particulate matter in the atmosphere and that the combined effect went beyond the threshold of resistance of the respiratory lining membrane, so that after a given period of time over a quite large area large numbers of people were affected. The gravity of the illness was not related to any specific toxic action of a solitary pollutant but generally, though not always, appeared to rise from the previous physical condition of the affected persons so that a fatal issue tended to occur amongst the asthmatics, the cardiacs and the elderly infirm.

The Donora Incident

The second incident of this nature occurred in October 1948 at Donora on the Monongahcla river in Penn-

sylvania about 30 miles south of Pittsburgh. Donora is a small town with a population of about 13,000 lying on the inside of a horseshoe bend of the river and connected by a bridge with the hamlet of Webster which has a population of about 1,000. On each side of the river valley hills rise to a height of about 400 feet and the area is highly industrialized with extensive steel, wire and zinc plants occupying about three miles of the river bank. Some coal mines are located in the vicinity and as the region generally is highly industrialized with other heavy industries situated in nearby towns there is much railway and river traffic in and around Donora. It is evident then that gross atmospheric pollution occurs from all three sources of contamination, viz., industrial plants, domestic fires and railway and river steam-driven transport.

During the last days of October 1948 a meteorological position, very similar to that in the Liège area in 1930, was set up. An area of high pressure with light or no winds existed over western Pennsylvania and the adjacent states and morning fog persisted in the Donora valley, where a condition of temperature inversion took place and caused smoke and atmospheric pollution generally to be clamped down in the valleys of its production. This combination of smoke polluted fog, neatly described by the Americans as smog increased in intensity so that on Wednesday, 27th October, it was sufficiently dense to arouse comment in an area where smog is not uncommon. It was reported that " streamers of carbon appeared to hang motionless in the air and that visibility was so poor that even natives of the area became lost." It continued until Sunday, 31st October, when a change in weather conditions brought winds and rain and the smog was dissipated.

During this period some 6,000 persons or 42.7 per cent. out of a total population of approximately 14,000 were affected in some degree. 10.4 per cent. of the population suffered severe illness and 20 deaths occurred. This mass illness was not only extensive in character but as in the Meuse valley episode it was almost explosive in its onset as will be seen from the following table showing the period in which the cases were reported.

Days	*Length hours*	*No. of cases reported*
Monday and Tuesday	48	60
Wednesday-Friday 6.00	56	750
Friday 6.00-18.00	12	1,600
Friday 18.00-24.00	6	2,100
Saturday 00.00-12.00	12	1,000
Saturday 12.00-24.00	12	400

It can be deduced from these figures that the threshold of respiratory resistance of the population generally was overcome on Friday, 28th October, that is, on the third day of severe smog when in the eighteen hours ending at midnight 3,700 cases of illness were reported.

The illness was of the nature of an acute irritation of the upper and lower respiratory tract both upper and lower systems being affected in about equal degree. In addition about one-third of those involved experienced gastro-intestinal symptoms, principally nausea with or without vomiting. The principal respiratory symptoms were sore throat, nasal discharge, choking, cough, tightness of the chest and difficulty in breathing.

As might be expected the incidence of affection increased markedly with age until almost two-thirds of all those 65 years of age and over were involved. Similarly the old tended to suffer more severely, nearly half of those succumb-

ing to a more serious affection as did persons suffering from bronchial asthma, heart disease or chronic bronchitis. Nearly 90 per cent. of persons with a previous history of asthma and nearly 80 per cent. of those suffering from heart disease or chronic bronchitis were affected by the smog, whereas the incidence rate for the population as a whole was 42.7 per cent.

Although 10.5 per cent. of the population suffered a disabling affection, in only 0.5 per cent. did it persist for longer than two weeks but four months after the disaster some 5 per cent. of persons still experienced cough and half that number had tightness of the chest. This persistence of cough and tight chest occurred principally amongst the elderly.

Finally, twenty persons died mostly within 48 hours of the onset of symptoms and amongst the fatal cases the existence of chronic cardio vascular disease was high.

I have quoted the statistical and clinical data at some length in order to emphasize the similarity of the picture with that of the Meuse valley incident. Once again there is a severely polluted atmosphere, arising from a combination of weather and geographical conditions in a heavily industrialized area, to which there is at first little or no physiological reaction and thereafter a period of non-specific reaction occurs abruptly in a large section of the population, the most severely affected among whom are the aged and those previously afflicted with cardio respiratory disease. Once again the investigators have reached the conclusion that no single pollutant has been in sufficient concentration to produce a specific pathological state in the individual. It has long been recognized, and the knowledge has been utilised in therapeutics, that a combination of chemical substances, each in small quantity, introduced into the body may produce an effect materially in excess of the sum of each substance when given separately. Again a highly soluble substance by virtue of its ease of solution acts principally on the upper respiratory tract but when adsorbed on particulate matter may reach, and be aided by the deeper respiration resulting from excess carbon dioxide in the atmosphere, the lung alveoli and produce its effect on the alveolar epithelium. The conclusion is that the ill-effects experienced were the result of the combined action of a number of chemical contaminants, particularly sulphur compounds, in association with fluid and solid particulate matter.

These are two incidents, explosive in character, involving a large section of the population at risk in sudden acute illness and subsiding rapidly with the elimination of the causal factors and they are broadly analogous to a water-borne epidemic of typhoid fever in the epidemiological field. The study of epidemiology, however, is not confined to high drama but includes the investigation of much less obvious outbreaks of infectious disease that nevertheless take toll of the population in terms of temporary sickness and even death.

The following table shows the total deaths from certain causes during the first eight weeks of the year :

	Week ending							
Deaths from	*Jan.* 5	*Jan.* 12	*Jan.* 19	*Jan.* 26	*Feb.* 2	*Feb.* 9	*Feb.* 16	*Feb.* 23
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Influenza	14	49	151	233	179	61	31	27
Pneumonia	59	118	186	297	282	126	71	49
Other resp. diseases	43	88	128	124	87	53	28	36
Heart disease ...	43	114	126	139	87	64	64	56
Total ...	159	369	591	793	635	304	194	168

Increased mortality rates associated with gross atmospheric pollution in our great towns are a well-known phenomenon and have been discussed at previous meetings of this society. Dr. S. I. A. Laidlow, Medical Officer of Health of the City of Glasgow, has been good enough to supply me with certain statistical information concerning the fog period in Glasgow in 1929.

Fog descended on the city at 8 a.m. on Tuesday, 1st January, 1929, and continued until 10.30 p.m. on Friday, 4th, its density being greatest on the 2nd and 3rd. Frost continued for some weeks and influenza prevailed during most of January and February.

The number of deaths is seen to have increased markedly in the week following the fog episode but whereas there is subsequently only a gradual increase in deaths from heart disease to a peak in the fourth week and in the case of " other respiratory diseases " the peak is reached in the third week both influenza and pneumonia deaths show a continuing and steep rise to the fourth week when in the former case the deaths are nearly seventeen times and in the case of the latter five times greater than in the first week. The implication is that the occurrence of fog conditions resulted in an increase, in the immediately succeeding days, in the number of deaths amongst those previously suffering from chronic cardio-respiratory disease and that the death rate reached higher levels in the succeeding two weeks as a consequence of the presence of influenza virus. An attempt at assessing the relationship between the fog episode in the first week of 1929 and a peak of influenza pneumonia deaths in the fourth week would take us into the realms of pure speculation but at least it can be said that a medical education is not needed to appreciate that preliminary exposure of a population to a severe fog of three and a half days duration is not the ideal method of developing mass resistance to an oncoming wave of influenza.

Dr. W. P. D. Logan of the Registrar-General's Office recently reported, in the *Lancet*, on the occurrence of fog conditions in London between the night of Friday, 26th November, 1948, and Wednesday, 1st December, and the following table is condensed from one compiled by him from the Registrar-General's weekly returns.

The picture in this instance is uncomplicated by the presence of an influenzal outbreak and the relationship between fog conditions and increased cardio-respiratory mortality in the same week, the 48th and the next succeeding week is immediately apparent. In his article Logan further reports that there was no increased mortality from either bronchitis or pneumonia at ages under 45, the whole of the increase falling on the older age groups.

Deaths from selected causes registered in London during weeks 44-51 *of* 1948.

Cause	*Week No.*							
	44	45	46	47	48	49	50	51
Influenza	1	2	3	2	3	4	2	2
Bronchitis	63	57	68	73	148	103	88	55
Pneumonia	32	42	46	29	73	71	67	51
Myocardial degeneration	95	97	125	102	133	135	103	79

It may well be that certain atmospheric contaminants, in defined circumstances, are present in sufficient concentration to produce specific illness in man but the experience gained from the four incidents quoted show clearly that this is not the problem facing us in the control of fog conditions arising from combined industrial and domestic pollution as ordinarily encountered so far. The search for a specific contaminant was not unnatural following

the work carried out on silicosis and other industrial hazards. Nevertheless, it is clear that the acute respiratory distress developing amongst members of the population in ordinary fog conditions is a non-specific reaction to irritation and the extent of the outbreak depends partly on the amount of the irritant present in the atmosphere, the duration of exposure and the physical condition of the affected person at the commencement of exposure. Hence severe distress may be caused and death ensue amongst those already suffering from chronic cardio-respiratory disease.

There is one other aspect of the problem that is worth contemplating. Between the extremes of complete recovery on the one hand and death on the other it is inevitable that some sufferers are left with a residual defect whether it be of the nature of an allergic response to future respiratory irritation or of an actual fibrosis and in this respect it is worth noting that the Donora investigators found that at the time of their investigation four months after the smog episode more than 5 per cent. of the population reported the persistence of cough and over 2 per cent. the persistence of tightness of the chest and difficulty of breathing. There is then as an aftermath the possibility of an initial degradation of some part of the respiratory system or the aggravation of a previous lesion a condition analogous with that often seen after whooping cough and measles, and so the sufferer is less able to withstand subsequent attacks on his respiratory system whatever may be their source.

In effect it is apparent that a smoke laden atmosphere by its irritant action on the respiratory system is harmful to the community and may leave residual respiratory defects in those exposed to it whilst injuring still further those with previously impaired cardio-respiratory tracts. By virtue of the gross variation from person to person that exists in the threshold of resistance to such irritation it does not seem possible to establish a pollution intensity point below which it could be said no harm would be done and the solution to the problem lies in the continuous application of measures designed to eliminate atmospheric pollution, particularly from domestic sources and those industrial sources where elimination is possible, and to reduce it in those others from which in the light of present knowledge it cannot be completely eliminated.

CURRENT RESEARCH ON THE POSSIBLE EFFECT OF SMOKE UPON THE INCIDENCE OF DISEASES OF THE LUNG

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Introduction

It has been pointed out in the previous paper that persistent smoke fogs often give rise to an increased incidence of respiratory diseases. Whilst the amount of suspended matter in the air is at such times exceptionally high, the duration is limited, and it is as well to remember that a certain amount is present throughout the year, and may produce some effect over a long period. The effect of suspended matter might well be cumulative, for some of the finer particles inhaled are

retained in the lung, and gradually build up an appreciable deposit in the lungs of town dwellers. Although the bulk of this deposit generally consists of carbon, which is believed to be at any rate less harmful than silica or asbestos dust, there are traces of other materials present which may not be entirely inert. It is difficult to ascertain directly what effects they may have, but the following observations give an indication of one possibility.

Statistical data

The number of deaths attributed to cancer of the lung has increased in the ratio 1 : 16.6 in men, and 1 : 8 in women in England and Wales during the period 1921-45. The increase may be due partly to improved diagnostic facilities, but that probably does not account for it all. Agricultural workers and coal-miners show incidences considerably below that in the general population, and Stocks (1947) has shown that there exists "... a steep downward gradient of rates from London, through large and small towns to rural districts, ..." and that wide variations occur between rates for different large towns. These latter rates are shown to be significantly correlated with the mean annual hours of sunshine in the respective localities, the correlation being greater for lung cancer than for bronchitis or respiratory tuberculosis. The differences in annual sunshine are due partly to smokiness of the atmosphere, and Stocks (1947) concludes "... that either smokiness of the atmosphere is an important factor in itself producing cancer of the lung, or sunshine is an important factor in preventing its incidence."

If smoke plays any part at all in the incidence of cancer of the lung, it is doubtful if all the variations quoted above could be accounted for by that from any one source. Clearly, coal smoke might be connected with the differences between town and country, but could hardly account for the rapid increase during the past twenty-five years. In this connection, tobacco smoke, or fumes from motor vehicles, must be taken into account. The possible effects of tobacco smoking are being investigated by a number of workers, and Wynder and Graham (1950) have published detailed results from an investigation of 684 cases of bronchogenic carcinoma. These show that a very high proportion of the cases were amongst smokers classed between "moderate" and "chain," being considerably higher than the proportion of such smokers in the general hospital population not suffering from cancer of the lung. Further, the proportion of cigarette smokers amongst these cases was higher than that in the same general population, and most had been smoking twenty years or more.

Experimental Work

Examination of samples of town smoke has shown that some substances known to have carcinogenic properties are in fact always present in trace amounts. Arsenic is one, 3 : 4-benzpyrene another and radioactive material a third. Arsenic is present in some coals, and part of it is emitted with the smoke. It is also present in some cigarettes (Daff and Kennaway, 1950), and a part is volatilised in smoking. 3 : 4-benzpyrene is a well-known constituent of coal-tar and some lubricating oils, and occurs in domestic soot (Goulden and Tipler, 1949). It has also been detected in the small amount of smoke emitted under certain conditions from the exhausts of internal combustion engines. The traces of radioactive material normally found in the atmosphere consist of the short-lived decay products of radon, derived from natural sources in the ground. Whilst the origin of these has nothing to do with smoke, they do attach themselves to smoke particles in the atmosphere. The carcinogenic action of such material has not been shown directly, but its possible effect should not be overlooked.

All three factors mentioned above show wide variations with time and place, and an attempt is being made to gain an idea of their variation with time in any one place, and of the variation in average concentration in different

localities. In this manner, it is hoped to detect any possible correlation between them and the varying lung cancer incidences referred to earlier. In point of fact, to determine small differences in the concentration of arsenic, benzpyrene or radioactive materials in the atmosphere in towns of similar size

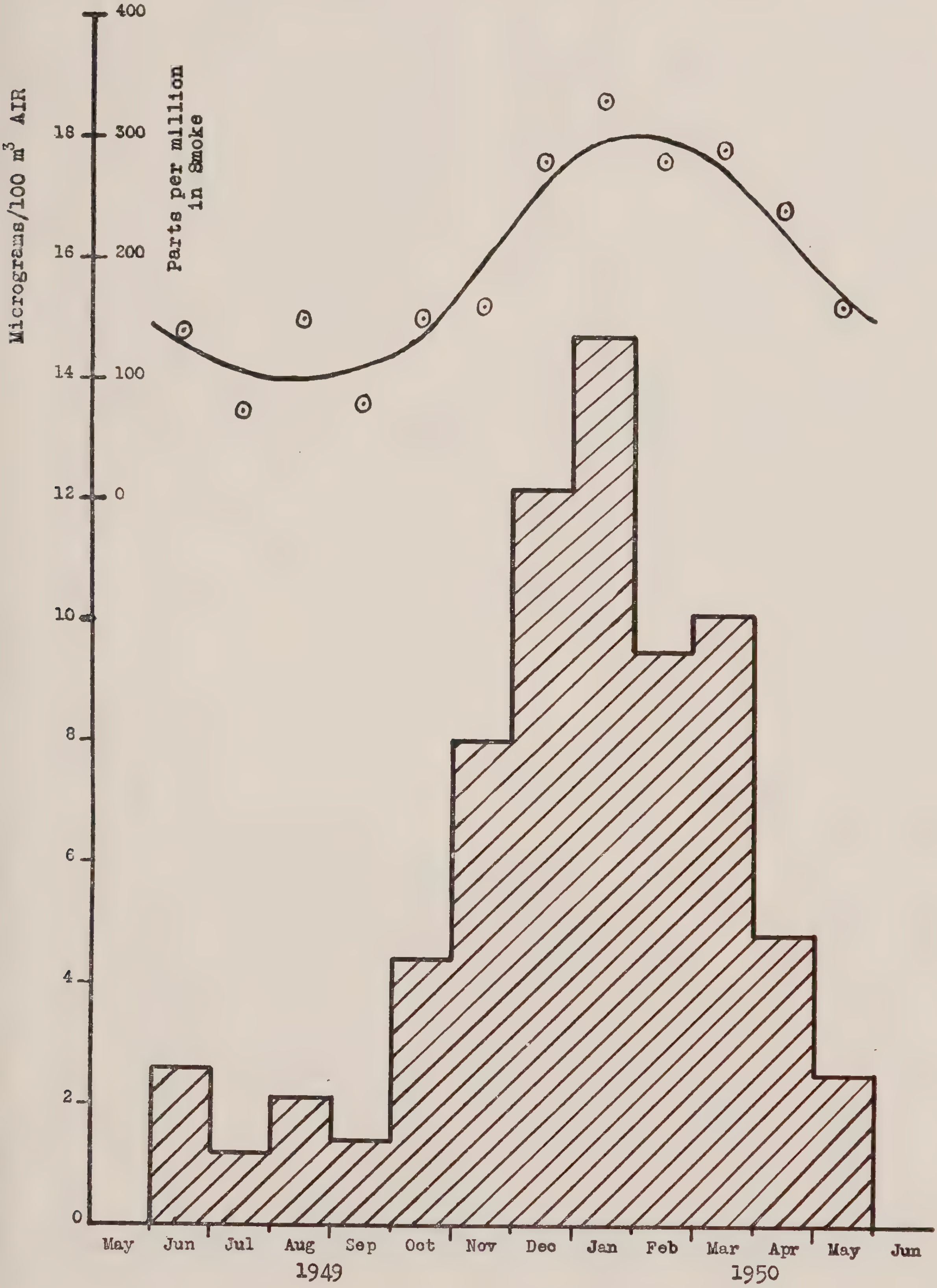

Fig. 1. Benzpyrene in smoke: Station A

would require observations over a long period of time, but it should be possible within a limited period to detect differences between towns of vastly different size, and between town and country areas.

To illustrate the procedure in experiments of this kind, there follows an outline of the method employed in estimating the concentration of benzpyrene in town air, together with some sample results.

Daily smoke filters, as run by some local authorities, provide suitable material, and are taken for analysis in batches of one month or more. The tarry matter in the smoke deposited upon them is extracted with acetone, and the complex mixture of hydrocarbons thus obtained separated as far as possible by chromatography. A solution is finally obtained containing a few micrograms of benzpyrene, together with some impurities difficult to remove. The benzpyrene is detected by means of its fluorescence spectrum, and its amount estimated by comparison with a standard. From the data supplied by the collecting authority, the total volume of air from which that amount has been drawn, and an estimate of the weight of smoke collected, are known. Hence the concentration of benzpyrene in the air, and its proportion by weight in the smoke collected can be calculated. Whilst the results should be regarded as estimates rather than precise measurements, they do give a fair indication of the trends. Such estimates are made on smoke filters from a number of stations throughout the year, or for complete yearly periods together. The values for any one month at one station may vary con-

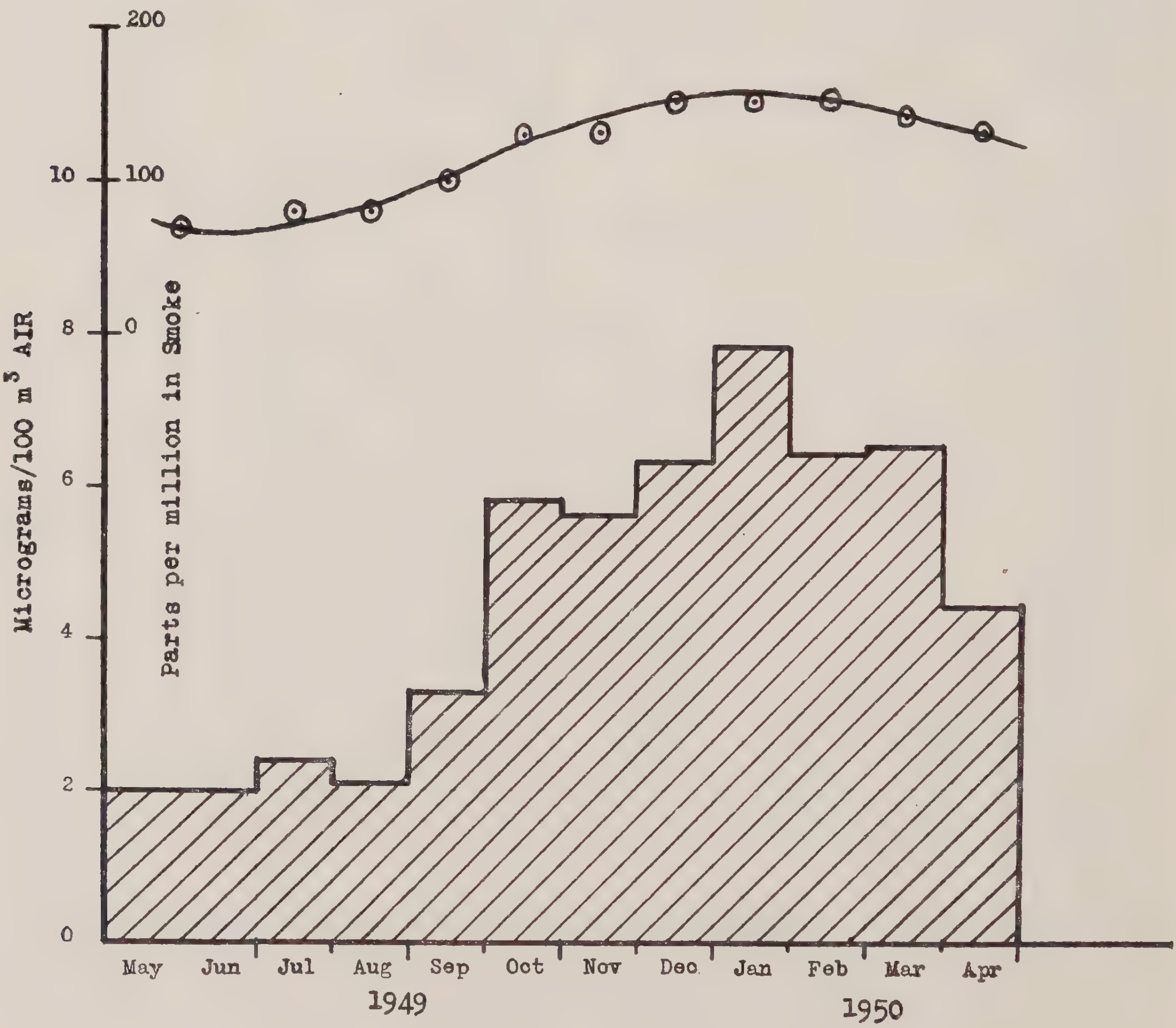

Fig. 2. Benzpyrene in smoke: Station B

siderably from year to year, but the twelve-month average should give a fairly satisfactory index of the general level of benzpyrene at that station. The average over many years would be better, but this cannot be undertaken at present. Random weather variations are chiefly responsible for the changes from year to year, and the effect of fog in particular will be considered below. Further, one cannot expect that the results obtained at a single station will apply to the whole town in which it is situated. However, most stations are situated close to the centres of their respective towns, and as such are taken to be roughly comparable.

Results

Figs. 1-3 show results for recent twelve-month periods at three stations of greatly differing size. Some interesting comparisons can be drawn between them, and these are summarised in Table 1. The stations are situated as follows: A is in a commercial district of central London, B is in a manufacturing district in the centre of a provincial city of half a million inhabitants, and C in the centre of a town of 40,000 inhabitants, in a coal-mining area. Summer averages are calculated for the five months May to September, and winter averages for November to March. The results cover a complete twelve-month period at each station, but the first and last months differ slightly between the three.

Discussion of Results

It can be seen that not only does the concentration of benzpyrene in the air rise during the winter at each station, but it then represents a greater proportion of the total suspended impurity. This clearly indicates that the source of the smoke responsible for the rise during the winter months is also one of the chief contributors of benzpyrene to the atmosphere. This source is most likely to be domestic fires, which accords well with the following considerations. Benzpyrene is present in the tarry matter in smoke produced in the inefficient combustion of coal.

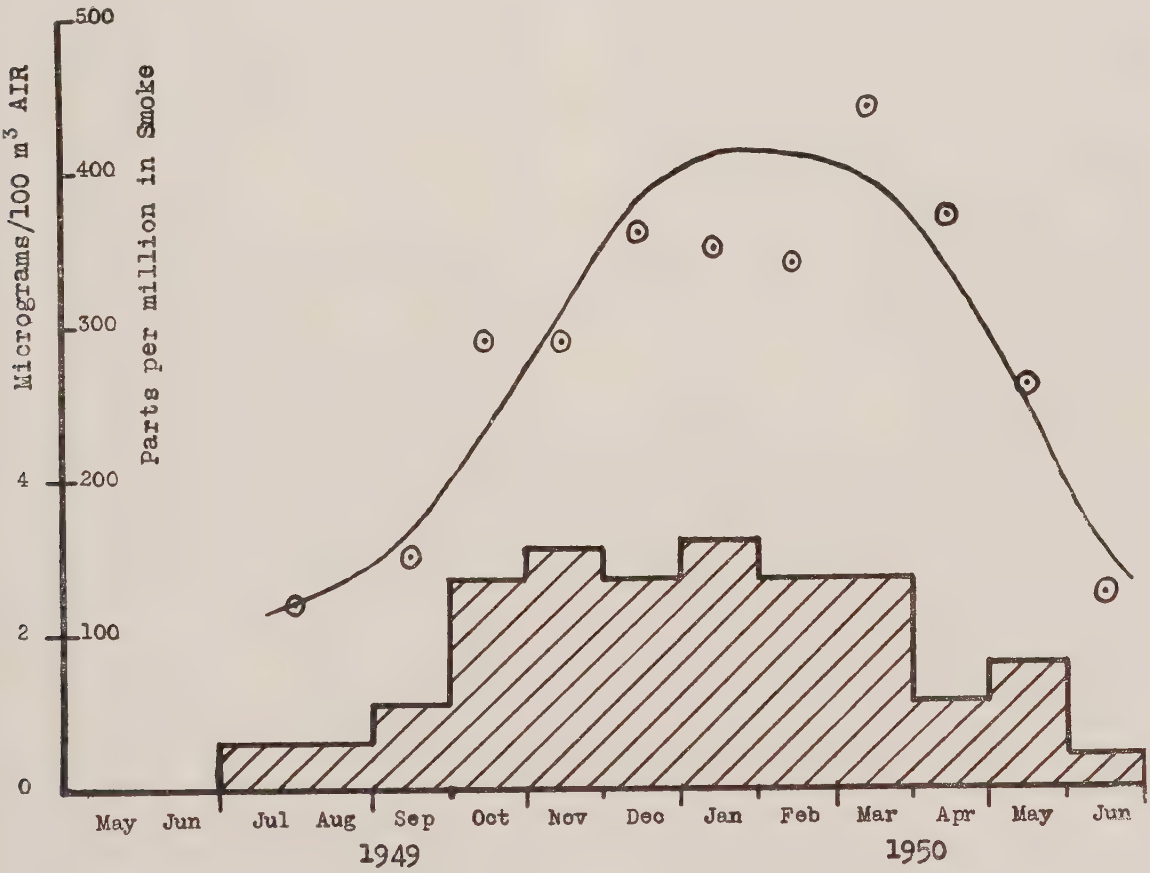

Fig. 3. Benzpyrene in smoke: Station C

Domestic fires are responsible for much of such smoke, smaller contributions coming from railways, collieries and some industrial undertakings. Benzpyrene is not emitted from chimneys of properly working industrial furnaces and power stations. The amounts of benzpyrene coming from road dust, motor vehicles, or any other source are likely to be small in comparison with that arising from coal. However, another point which requires further investigation is the particle size distribution in suspended matter, and in smoke from particular sources. The chance of a particle reaching, and being retained in, the lung will depend on its size, so that we should perhaps study the distribution of benzpyrene in various size ranges rather than in all those collected by the smoke filter. In view of this, it may be that domestic smoke has been overrated above as a prime source of potentially harmful benzpyrene.

The results expressed in Table I suggest the following conclusions regarding the three stations. A shows the highest twelve-month average concentration, and the greatest range. This is in accordance with the conditions amidst a large population producing much domestic smoke during the winter, with but little during the summer. The minimum gives a rough upper limit to the general level due to non-domestic sources. The average proportion of benzpyrene in the smoke is intermediate between that at B and C, and indicates that industrial smoke contributes less to the total suspended matter than at B, and more than at C. B shows an intermediate twelve-month average concentration, in accordance with the intermediate population of that area. The summer average, however, exceeds that at A, and the range is the smallest of the three. This may be due to a greater use of domestic fires during the summer at B than at A, or to a greater influence of non-domestic sources, which vary little between summer and winter. Smoke from industrial chimneys in the vicinity of this station may contain some benzpyrene, but as the proportion is likely to be considerably less than in domestic smoke, the effect would be to reduce the proportion in the smoke as a whole, which may account for the relatively low average value of 115 parts per million. C, situated in much the smallest town of the three, shows the lowest concentration and an intermediate range, whilst the proportion in smoke is the highest. Collieries may contribute a little along with domestic fires to the benzpyrene content in this area, and there is little other industrial smoke.

Effect of Fog

During a fog, the same atmospheric contaminants are still being emitted at

Benzpyrene Concentration	*Micrograms per* 100 m^3 *air*			*Parts per million in smoke*		
Station	A	B	C	A	B	C
Minimum	1.2	2.0	0.4	75	70	120
Maximum	14.7	7.8	3.2	330	150	440
Range {Max. / Min.} ...	12.3	3.9	8.0	4.4	2.1	3.7
Summer Average ...	2.0	2.4	0.9	120	80	155
Winter Average ...	10.9	6.5	2.9	270	140	360
12-month Average ...	6.5	4.5	1.9	190	115	270

Table I. Benzpyrene in smoke: summary of results at three stations

the same rate, and accumulate at a low level. An example of the effect of this on benzpyrene concentration is shown in the results quoted in Table II. The month cited showed a rather high average smoke concentration, and included three consecutive days of fog, referred to as Z-days (smoke conc. 1.25 mg./m´), the papers from which were selected for separate estimation.

Period	*February*, 1949			*February*, 1950
	3 *Z days*	25 *other days*	*All* 28 *days*	*All* 28 *days*
Smoke conc. mg./m³	1.73	0.40	0.55	0.44
Benzpyrene conc. μg./100 m³. air	32.8	7.2	9.8	6.4
Benzpyrene in smoke p.p.m. ...	190	180	180	150

Table II. Benzpyrene in smoke : Station B.

The average benzpyrene concentration during the three Z days rose to over four times that during the remaining twenty-five, giving a whole month average 36 per cent. higher than the latter, and 53 per cent. above that for the corresponding month in the following year. This illustrates the way in which certain weather conditions may cause irregular variations in the benzpyrene concentration from month to month, or year to year. The result that the proportion of benzpyrene in the smoke rose but little during the three Z days as compared with the rest of the month shows that the fog produces a change in quantity rather than quality of the suspended matter. Whether or not the amount of benzpyrene reaching the lung is substantially raised during fog is another matter, as the particle size distribution is likely to be different under such conditions.

Conclusion

The chief result of the present investigation is that the general level of benzpyrene increases, though only slowly, with increasing urbanisation. Local conditions may produce anomalies in some cases, but it is expected that a similar trend will be observed at the several other stations being investigated. Even in country districts, a little smoke is always present, and if large enough samples can eventually be obtained, estimates of benzpyrene will be made for comparison with urban areas.

Acknowledgments

This work forms part of a study of atmospheric pollution in relation to cancer of the lung, supported by the Medical Research Council, and under the direction of Sir Ernest Kennaway. Full details will be published elsewhere. We are indebted to Dr. A. R. Meetham (late of the Fuel Research Station, Greenwich), and various local authorities, for arranging the supply of smoke filters.

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General information has also been drawn from the following :

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Atmospheric Pollution in Leicester. H.M. Stationery Office, London, 1945.

The Investigation of Atmospheric Pollution, 26th Report. H. M. Stationery Office, London, 1949.

James Law (Sheffield) said he would like to congratulate Dr. Burnett and Mr. Waller on their very interesting papers dealing with pollution and its effect on respiratory diseases and diseases of the lung, though apparently the causes of these diseases emanated from different sources of pollution.

Dr. Burnett emphasized the danger of grit and sulphur gases from combustion, and Mr. Waller built up a theory on the presence of "benzpyrene," which he understood was a tarry by-product from low temperature heating of bituminous coal, and due to bad combustion in domestic fireplaces.

As a smoke abatement officer, he was gravely concerned about the increase in dust and sulphur emission from industrial works and from electricity power stations; because their statistics showed that both were on the increase in most of the industrial towns.

Dr. Burnett had told them of the Meuse Valley and Donora incidents, which should bring home to them the fact that similar incidents could happen in Britain should similar atmospheric conditions occur in some of their industrial valleys.

During the past twelve months a number of towns had installed gauges for pollution recording, and he had been particularly interested in the records that had been shown. For some years the pollution gauges at Attercliffe, Sheffield and Phillips Park, Manchester, had "topped the bill" with regard to solid matter deposited, averaging about 45 tons per square mile per month, but recently some of these other records had made Attercliffe and Phillips Park look comparatively clean. He referred particularly to the N.E. coast. With regard to sulphur deposit, it was estimated from the figures given by the British Electricity Authority alone that the four power stations in the Don Valley emitted about 120 tons of SO_2 per day with coal of a low sulphur content of 1.8 per cent. Ironwork corroded rapidly, stonework showed signs of disintegrating and vegetation became blighted in the path of these gases, yet the Authority would only try to palliate the nuisance by raising the height of the chimneys and hoping it would dissipate the sulphur. From the chemical works the emissions were so bad as to cause watering of the eyes and coughing when in the neighbourhood. A gauge at Bessemer Road, Sheffield, showed a daily average of 152.2 milligrammes per 1,000 square centimetres per day or fourteen times that of the residential area during 1949. This matter had been taken up with the Alkali Inspector from the Ministry, who stated that the standard of four grains per cubic foot was never exceeded. A revision of the standard had been asked for but had not been granted.

He knew they would think that he was a scare-monger and a pessimist about these matters of pollution, but he did want to remind them that the pollution of the atmosphere was on the increase and though as yet it had not become a definite menace, we have no guarantee that the atmospheric conditions might, at any time, change so that incidents similar to those related by Dr. Burnett might occur in their town or his. He asked every delegate to see that pollution and sulphur recording gauges were installed and the records carefully watched for abnormal conditions which might impair the health of the residents. Where it was known that the source of such pollution existed, strong action should be taken to reduce such pollution to a minimum. It was only by careful investigation and definite action that their cities could be made cleaner.

G. W. Farquharson (Birmingham) asked Dr. Burnett whether, in his opinion, such a dramatic incident and increase in mortality rate, could happen in so short a time in any of our British industrial centres. He pointed out that there are several areas in the Midlands, highly populated and heavily industrialized, with such premises as Chemical, Galvanizing, Tinning, Casting, Melting and other metallurgical processes, with no doubt the usual quota of inhabitants suffering from respiratory ailments.

Had Dr. Burnett found in his study of the subject, whether the high sulphur content of the fuel in use in Donora, was a contributory cause, or whether there was any evidence of lack of supervision, either by legal means or otherwise, by any of the officials concerned in atmospheric pollution ? Mr. Farquharson reminded the delegates that in this country it was the duty of the local authorities, to use to the full extent, both legally and advisory, the enactments provided for effecting a reasonable abatement of any pollution of the atmosphere.

We knew there was still room for improvement in regards to these legal means, and progress had been slow, but on the credit side, they must acknowledge the Ministry of Health Circular in relation to the provision of approved domestic fuel burning appliances in new housing development, but from a national point, the country was still a long way from implementing many of the recommendations of the Simon Report on Domestic Fuel Policy.

In regards to Mr. Waller's paper, Mr. Farquharson asked if there was any variation in the mortality rate figures in regards to cancer of the lung, during the winter or summer months ? It would appear from the papers that as lung cancer was a respiratory disease, statistics should show seasonal variation.

Dr. H. E. Crossley (British Electricity Authority) raised a doubt about the precise cause of fatalities in the Meuse Valley disaster. He referred to papers published since that time, putting forward the suggestion that the main cause of the deaths which occurred was fluorine compounds from a nearby fertilizer works, and not oxides of sulphur as at first supposed. If this was so it might account for the difference in toxicity between this fog, possibly other cases, and the fogs which have been experienced commonly in the industrial districts of Britain. He referred to the paper dealing with the bad effects of certain tar compounds, and said that at his house he could claim to be free from the charge of making any addition to pollution by tarry smoke as the domestic heating was entirely by means of high temperature coke. He suggested that this was a contribution that was worth following wherever practicable, particularly by delegates, as an example to others.

Dr. Crossley then referred to the contribution by Mr. Law, particularly to Mr. Law's disbelief of the benefits of tall chimney stacks. He said that ten years of observations (published officially) on sulphur pollution round Battersea, the first two years with gas washing plant in action, the next six years with no gas washing, and the final two years with half the station on gas washing, had shown no significant differences. He pointed out that Battersea Power Station has tall chimneys.

F. V. A. Smith (Chief Sanitary Inspector, Burton-upon-Trent) said that after listening to the speakers he was forcibly reminded of the old maxim that " prevention was better than cure," but when one realized the amount of grit and ash emitted from industrial chimneys today he was perturbed at the possible danger to health from this source of atmospheric pollution.

In Burton, as in many other towns, large quantities of fine ash from industrial chimneys covered not only the exterior but also the interior of dwelling houses and perforce must be affecting the health of the occupiers.

This nuisance was due to the very inferior and dust-like fuel which, because of the present economic position, was being supplied to industry today. This serious menace to health could be largely eliminated by the proper use of balanced, forced and induced draught to the boiler furnaces.

To remedy this state of affairs, it was essential for the very closest liaison between officers of local authorities, regional fuel engineers of the Ministry and the industrial users of this fuel so that the maximum effort might be applied to reduce this very serious nuisance and predisposing factor to bronchial ailments.

S. H. Richards (Fuel Research Station, Greenwich) said that the obser-

vations of atmospheric pollution by sulphur dioxide referred to by Dr. Crossley were for two stations only. Since 1945 the Fuel Research Station had been carrying out a survey of the incidence of pollution by sulphur dioxide in the south-west London area, in which some 30 observing stations were employed. It was hoped that the results obtained in this survey would throw some light on the effect of flue gas washing at the Battersea generating station on the concentration of sulphur dioxide in the atmosphere in its vicinity.

F. J. Redstone (Chief Sanitary Inspector, Bristol) said that a great deal had been heard that afternoon about smoke pollution of the atmosphere, and whilst this was serious, had not the time arrived for greater consideration to be given to other air pollutants? Reference had been made to radioactive material and he felt sure that this, with dust, fluorine, and other chemical emissions would need more attention in the future and form a definite part of the work carried out by this Society.

Were they all satisfied that this job of cleaning up the air was being vigorously tackled in all areas? The speaker suggested that the efficiency of abatement work and the interest needed for preventing fresh sources of pollution was intimately bound up with the number of qualified smoke Inspectors available to local authorities. He asked that this point be more widely appreciated, and that the holding of special qualifications on this subject which meant time, effort and expense on the part of the individual, should be suitably recognized.

One last point—as Chairman of the Publicity Committee, he appealed to everyone present to make a personal approach to non-member authorities with the object of bringing them all into the work of the Society.

Dr. W. R. Martine (Birmingham), in moving a vote of thanks to Dr. Burnett and Mr. Waller, questioned whether the papers had in fact been a rehash, as stated by Dr. Burnett. He had heard many papers on the subject of smoke and health, and he felt highly privileged to have the opportunity of complimenting the authors of two papers which, in their respective ways, both contributed a number of new ideas for the benefit of those whose duty it was to put over the case against smoke to the public.

These papers were not mere recapitulation, nor a summary of incidents, but a survey which provided food for thought. There might be some hesitation in the medical mind against complete acceptance of certain of Mr. Waller's findings, and much more would have to be done before these could, or would, be generally accepted. Mr. Waller had not, for example, discriminated between primary and secondary lung cancer. He had, again, underlined the danger arising from cigarette smoking, but had not referred to the pipe in this connection! Had this been deliberate, and was the pipe smoker in any way more immune to this risk?

One point which both speakers had rightly stressed was the diversity of atmospheric pollutants. In Birmingham fumes from industrial processes were equally a source of nuisance, with smoke from kilns in the potteries or drop forge furnaces in Willenhall, and the Midlands Regional Advisory Council had long since recognized the fact, changed their name and widened their scope. It was good to hear that this view was being put forward from other parts of the country also.

Dr. Burnett, in reply, stated that given the requisite climatological and geographical conditions an incident such as that at Donora was just as likely to occur here as anywhere else, but possibly our much maligned climate was hitherto our main safeguard against an occurrence of such a major catastrophe. The sulphur content of the Pittsburgh fuel used did not appear to be unduly high but the sintering process in the zinc plant also appeared to be a major factor in sulphur pollution. Generally speaking, however, this form of pollution came from a wide variety

of sources and it was the total concentration of it and other irritants that mattered rather than the amount of one particular irritant produced by one process. This he thought applied equally to the Meuse disaster. One particular substance such as fluorine might be in sufficient concentration to tip the scales but the harmful effects particularly in the conditions applying generally in this country were non-specific in character and related to total irritation from all sources. The attack against sulphur was due simply to the fact that it was the main atmospheric irritant and a reduction in its output would make the greatest contribution to the solution of the general problem. That view, of course, did not constitute an excuse for ignoring other forms of irritant.

R. E. Waller, replying to Mr. G. W. Farquharson, pointed out that in general, many years might elapse between the actual onset of lung cancer and its first manifestations. It was, therefore, unlikely that whatever its cause, its incidence would show any seasonal tendencies. This was illustrated by the monthly figures for deaths from lung cancer during 1948, which showed only random variations from month to month.

In connection with radio-activity, mentioned by Mr. F. J. Redstone, the exceptionally high incidence of lung cancer amongst miners at Schneeberg and Joachimsthal has been attributed to the presence of considerable amounts of radio-active material in the mines. No large deposits of radio-active material were known in this country, but the small amounts present everywhere do give rise to a trace of radio-active material in the atmosphere. Measurements of this were being made to determine whether it had any bearing on the problem of lung cancer. The increasing production and use of radioactive isotopes represented a potential hazard, but one which was already under careful control at its source.

With regard to Dr. W. R. Martine's comments, the statistical data quoted was based entirely on cases stated to be of primary lung cancer. From work published to date, it might be concluded that if tobacco-smoking played any part in the incidence of lung cancer, the effects of cigarette smoking were much more pronounced than those of pipe smoking. Lung cancer was becoming a grave problem, as could be judged from the latest available statistics, which showed that in England and Wales during 1948, 8,597 male deaths were attributed to it, representing 3.6 per cent. of all male deaths during that period. The problem was being actively pursued from many directions, and although the results reported in the above paper were suggestive, much further work was required before any definite conclusions could be reached regarding the rôle of various air pollutants in the ætiology of lung cancer and of other respiratory diseases.

SMOKE PREVENTION AS A FACTOR IN NEW HOUSING

Cyril H. Walker, O.B.E., M.C., F.R.I.C.S., F.R.I.B.A., M.I.Mun.E.

Director of Housing and Valuer, London County Council

The Council's current policy (1). The present policy was adopted in the consideration and approval of the new type post-war dwellings and provides for gas ignited coke burning open fires in living rooms and back boilers for domestic hot water supply with electric immersion heaters for summer use.

The principal bedroom is provided with built-in gas and/or electric fire, other bedrooms have power sockets for portable electric fires.

Types of apparatus (2). *Flats*—Open fires with back boilers—"Fulham," "Vector" and "Metro," "Chevin."

Cottages—As above but with convection providing heat to two bedrooms.

N.B.—All these fires are interchangeable, i.e., are so standardised that they all fit the same sized openings and water connections.

Other types of apparatus (3). *Flats*—Coke burning open fire with back boiler suitable for use with two or three radiators. "Neofire" or "Fulham."

Higher Income Group 2-storey houses—Radiation, Ltd., Whole House Heating Cabinet to provide convected heat throughout the house and ample domestic hot water.

N.B.—For the time being this experiment has been limited to 48 houses in which special "open planning" is essential.

Types of Fuel (4). Whilst primarily designed for coke burning the whole of the fires above-mentioned will burn anthracite, bituminous or steam coal efficiently.

With bituminous or steam coal it is desirable for efficient working that the back boiler flues be cleaned weekly.

N.B.—There has been some difficulty over recent years in obtaining adequate coke supplies, particularly on out-county estates, but this position would now appear to be improving.

Central Heating (5). In late 1945 the Council decided to experiment with low pressure central heating and hot water supply to certain blocks of flats forming in some cases portions of a large estate of dwellings fitted with normal apparatus. A case in point is that of Woodberry Down Estate, where two eight-storey blocks comprising a total of 160 lettings are supplied with central heating and domestic hot water supply from a basement boiler house equipped with two coke-fired cornish boilers. The conversion of the boilers to oil fuel is under consideration. Other central heating schemes either approved or building are Kilburn Vale, Ruskin Park, Stockwell Gardens and Chartfield Avenue.

Whole house heating (6)—See (3).

District heating (7). Considerable thought has been given to district heating, particularly in relation to some of the Council's large out-county schemes, but due to the lack of legislation it has not been possible for the Council under its own authority to make any progress.

An attempt was made to introduce a General Powers Bill in the 1948-49 Parliamentary Sessions, but without success.

The Council is, however, collaborating with and participating in the Dagenham Borough Council's district heating scheme for Heathway Park Estate, part of which will be erected and owned by the London County Council, but space heating and hot water will be supplied by Dagenham Borough Council from their central apparatus connected with the Refuse Destruction Plant.

The whole of the houses, flats, etc., on the new estate will be without solid fuel burning fires. The consulting engineers for the scheme are Donald Smith and Partners.

An interesting experiment on a small scale is that of Collingwood Estate (Darling Row), Bethnal Green, by which 178 flats receive central heating and hot water supply from the Albion Brewery (Mann, Crossman and Paulin, Ltd.), which is separated from the estate by a roadway.

The principle of generation adopted here is that the high pressure exhaust steam used by the Brewery in the turbines generating its power requirements and which otherwise would be lost by condensation or atmospheric exhaust, is passed through calorifiers on the Council's site, so heating water for the space heating and hot water supply for the flats and returning as condensate to the Brewery. By this means it has been possible to omit all solid fuel burning fires in flats and substitute an entirely automatic system of central heating and hot water supply to the 178 flats. As the processes of the Brewery are of 24-hour duration, continuous supply is assured, though temperatures are purposely lowered during the night, but to guard against all eventualities the Council has provided a stand-by manually-fired boiler plant to take over the load if necessary. The local Borough Council co-operated in opening up the road and building the necessary pipe duct.

Effect on cost of construction to tenants (8). The installation of central heating does add to the constructional cost and also adds to the weekly charge to the tenant. This should, however, in the main, result in the gross expenditure which the tenant has to face in the way of rent and fuel costs being lower. This cost is largely in the hands of the tenant so far as the proper use of heating and hot water is concerned, and I am of the opinion that the Danish method of having consumption meters fixed to the apparatus, although it is said that these may not be strictly correct, have a good psychological effect on the tenants and thus ensure economy.

The average cost to the tenants is between nine and ten shillings a week. This is very little more than would be the cost of the more usual methods of heating and hot water supply and undoubtedly central heating affords a better service in that there is more efficient heating and a constant hot water supply is available at all hours. Moreover, central heating provides background heating in passages and to bedrooms to a much greater degree than is possible with standard equipment.

In connection with the installation of central heating it is well to give thought to double windows which, from enquiries I have made, will not result in extra cost. Any extra cost of these is off-set by economies in the size and magnitude of the heating installation.

SMOKE PREVENTION AND THE NEW TOWNS

C. A. C. Turner, O.B.E., T.D., F.R.I.C.S., F.L.A.S., A.C.A.

Chief Executive, Crawley Development Corporation

1. Introduction

The Development Corporations which have been established under the New Towns Act, 1946, to design and build New Towns in various parts of the United Kingdom are concerned with the design and construction of the fabric within which healthy, efficient and happy communities can make a maximum contribution to the productivity and standard of living of this country.

The work of the Corporations would not, therefore, be complete unless it embraced the objective for which your Society has been working for 21 years in securing the most efficient use of fuels to provide heat and power without pollution of the atmosphere or wasteful consumption.

The architects and engineers who have the task of designing buildings and heating and power equipment, and the consumers for whom they design, have to-day the advantage of the research, experiment, improved techniques and general education of the consuming public which have grown up during the period in which your Society has come to manhood.

2. The Scope of the Work of the Corporations for Smoke Prevention

(a) The Field for Design

The New Towns so far designated vary in size and character. Some of the towns such as those sited around London are designed to receive industry, commerce and population from an existing centre which has become over large. These towns must provide for the development of new industrial and commercial areas within their boundaries.

Other towns such as Aycliffe in Durham and Cwmbran in Wales are designed to accommodate a population for whom there is already, in the main employment in the vicinity and to which people are at present travelling from surrounding areas.

The Corporations are therefore, in general, concerned with the whole field of fuel consumption embracing industrial, commercial and domestic uses.

(b) Local Conditions

Since the New Towns are widely scattered, there are considerable variations in climatic and weather conditions.

In all cases the designated area of the New Town contains some degree of existing development and population but this again varies considerably as can be seen by comparing three of the towns around London; Hemel Hempstead has an existing population of 22,000, Harlow has 4,300, while Crawley has 10,000.

Some towns, such as those in the mining areas, are near sources of solid fuel while others have to meet heavy transport and distribution costs. This factor has an influence upon local tradition and custom in the use of fuel.

The development of the electricity grid system and the tendency towards regional gas grids means that in the main the New Towns will not require new electricity generating stations and gas manufacturing plants within their boundaries. In the case of Crawley, electricity will come from the grid and gas will be brought by pipeline from Croydon 19 miles to the north. Each Corporation has had to approach its task against a background of the local conditions prevailing in its area but these have not affected the common responsibility of the Corporations to decide in the first instance whether the provision of heat can be treated comprehensively by means of a district heating scheme on a town basis.

3. Comprehensive Schemes for Heat Distribution

There can be little doubt that hot water and the means for heating enclosed spaces on tap, without the labour and dirt associated with the burning of fuel, would be an attraction to both the industrialist and the housewife.

It has been the responsibility of Corporations to decide at an early stage in design whether the provision of heat on this basis could be undertaken as an economic investment. The decision to install a comprehensive district heating or hot water scheme must be taken at an early date in design if the maximum economies are to be secured, not only from the point of view of the cost of installation of pipes and ducts but also from the point of view of modifications in building design.

It is not within the scope of this paper to discuss technicalities and costs of district heating and piped hot water schemes. It has been apparent, however, to most Corporations that there is a paucity of reliable data on which to base estimates of capital and working costs of district heating schemes in this country. Corporations have had the greatest assistance in their consideration of these matters from the Ministry of Town and Country Planning, the Ministry of Fuel and Power, the British Electricity Authority and research organizations in this country and abroad and from the operators of schemes here and overseas.

The main factors which are being considered are :—

(*a*) *Capital and Operating Costs for the Installation*

In considering these estimates, regard must be had not only to the capital and working costs for the heat source and distributions mains, but also the heat distributing installations in buildings and the total effect of the use of piped heat on the design and cost of construction of the buildings themselves.

The density of buildings and the distances from heat sources are material factors.

(*b*) *Heat Sources Available*

It has been necessary to examine whether an electric generating station producing a heat by-product could be economically sited within the boundaries of the town, both from the point of view of economical generation of the electricity and use of the heat by-product. If total economy could not be achieved in the siting of an electricity generating station, it has been necessary to consider whether a straight thermal plant could be justified on the basis of the local price of fuels. Consideration of a heat pump is, of course, out of the question unless there is a large river near the town.

(*c*) *Consumption*

Consideration has had to be given to the maximum and minimum consumption of heat at varying periods of the year and the likely duration of the maximum consumption period according to the climate and habits of the people. The possible requirement for industrial process heat has also had to be reviewed.

(*d*) *Economics*

The calculated economic cost of heat to the consumer has had to be compared with the price at which the consumer could secure heat by traditional means embracing the use of smokeless fuels, electricity and gas.

In this connection, experience shows that even where hot water alone has been available on a piped system to the domestic consumer at a flat rate charge, consumption rises considerably above that which prevails where traditional types of hot water heaters are used under the control of the occupier.

After careful consideration of the available data, the Crawley Corporation did not consider that the very large investment which would be necessary to develop a comprehensive district heating or hot water service in the New Town would be justified and I believe that other Corporations are reaching the same conclusion.

This decision does not, however, preclude the development of small group schemes for individual groups or blocks of buildings where the circumstances are propitious.

4. Detailed Design for Fuel Economy and Smoke Prevention

You have other papers before you this morning dealing with the work of design for domestic fuel economy and smoke prevention. At Crawley and in other New Towns the new houses which are being built are serviced with electricity and gas ; boilers and fireplaces are of the latest types designed to burn smokeless fuels and make the maximum use of the resulting heat by convection and radiation. Adequate insulation to maintain an equable temperature within buildings is a normal part of the work of design and is part of the problem which faces the architect and engineer in relating cost to value when construction costs are high.

In the industrial field the drive for efficiency and lower costs of production is clearly leading those responsible for the design of new factories and their heating installations to pay very great attention to the efficient consumption of fuels. At Crawley 99-year building leases have already been signed by five firms who are erecting factories to designs prepared by their own architects and consulting engineers and which have been approved by the Corporation. The first of these factories, being built by Messrs. W. C. Youngman Limited of Wandsworth, will come into production in the New Year. In addition, the Corporation are building a range of standard factories of about 5,250 sq. ft. which are being let on 21-year leases to firms who do not wish to invest in their own buildings. Nine of these factories have been let and the first four will be occupied in October this year.

Experience is proving that each factory has its own problem connected with the provision of background and process heat, and the conditions are not yet such as would justify the installation of a group heating scheme in the first part of the industrial area which has been opened up amounting to some 50 acres.

5. Conclusion

While it has not been possible to embark upon comprehensive schemes for district heating or piped hot water in the New Towns so far designated, the detailed provisions which are being incorporated in the design of the industrial, commercial and domestic buildings should enable a New Town to say with the well-known gentleman in the advertising pages of your journal, " Give up smoking ? I never started !"

It is our hope that the inhabitants of these towns will enjoy a high standard of heating with economy and that these new communities will not contribute to the formation of " smog " and fog but will hope to live in smokeless air.

HOMES AND SMOKE; THE INCLUSION OF NEW HOUSES IN THE SALFORD SMOKELESS ZONES SCHEME

Alderman G. H. Goulden, Salford City Council

Homes and Smoke, etc.

Whoever first promulgated the principle of achieving a smoke-free atmosphere through the progressive prohibition of smoke production, area by area, may not, at that time, have been convinced that it would be seriously attempted in this country. The advantages of this method above those of any previously devised become more apparent the closer the possibilities are studied. It now interests a much wider field of thought than the confines of this assembly, and since the principle received the approbation of a Government-appointed committee, momentum has been imparted to a movement which may well result in the greatest reduction in smoke pollution ever witnessed here.

That body rightly pointed out the impracticability of prohibiting all smoke, even in a moderately sized town, by one comprehensive enactment as has occurred elsewhere. Such sweeping changes can only be accomplished through the agency of Donora or similar episodes which the most ardent smoke abolitionist would not wish to see repeated in this country. Adaptability to the particular needs, peculiarities and future development of a locality is one of the chief merits of the smokeless zone, but always there is the prospect of cultivating the rapid growth of enthusiasm for smokelessness, culminating in a popular demand for full embracement by industry of the scientific combustion methods now available and largely ignored.

Stimulation of individual interest in smoke pollution is an urgent need to promoting a strong public opinion determined on increased air purification.

Two years ago Salford received Parliamentary sanction to prohibit the emission of smoke in any area or areas within the city, and although little concrete information was then available a short report was presented to the Harrogate Conference twelve months ago.

Much headway has since been made. A report outlining the scheme has been presented to the City Council and a Smokeless Zone Order has been prepared and submitted for confirmation to the Ministry of Health. The operative date is at the discretion of the Minister. A local enquiry into the project may or may not be necessary, dependent on whether any objections are made and not subsequently withdrawn.

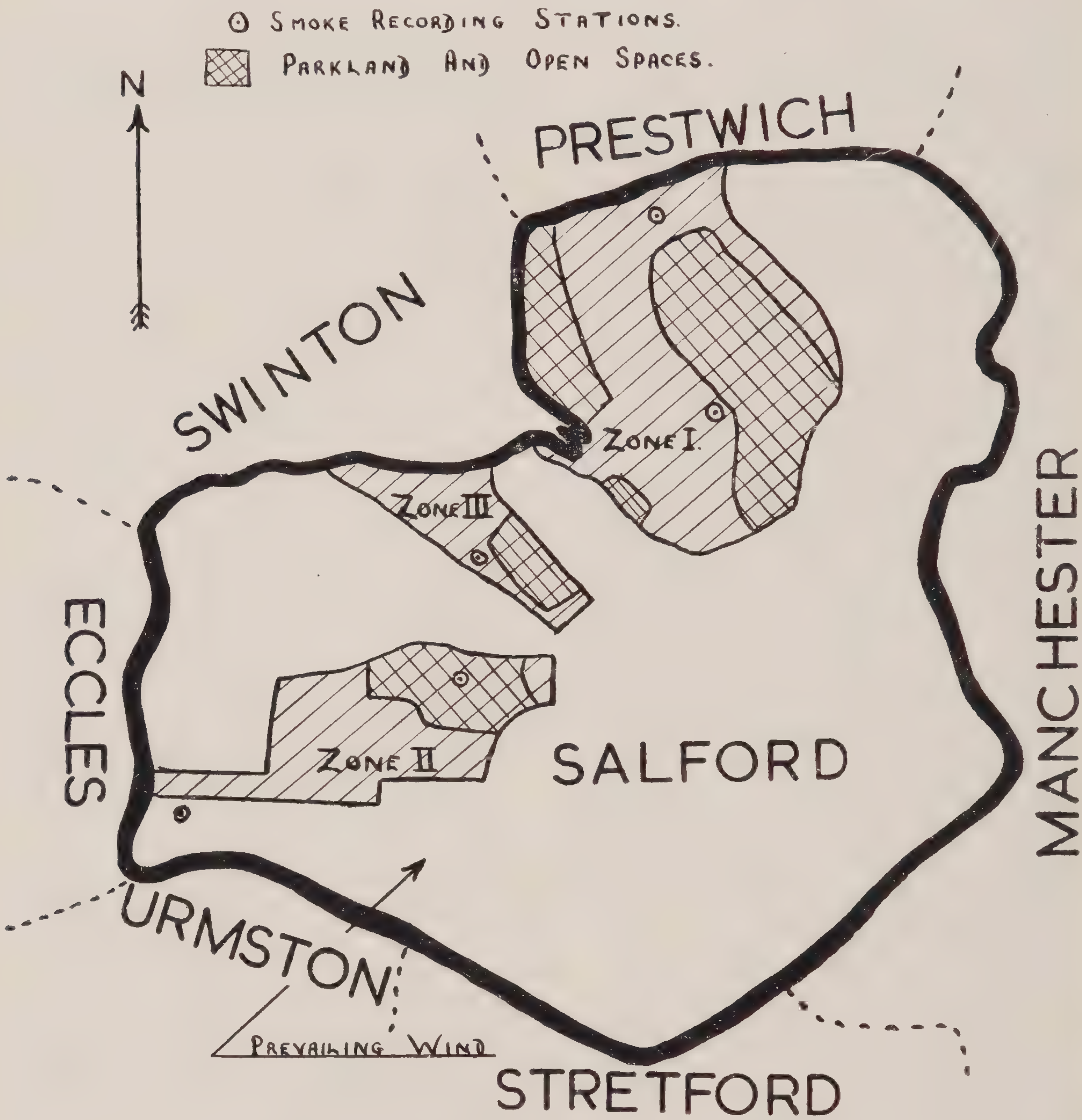
This stage has only been reached after much exploratory thought and preparation. A start had to be made at foundation level and there was some concern at the reception a Smokeless Zone scheme would receive, but as time elapsed it became apparent the venture was not to become a mirage or end in smoke! It would not be satisfactory to view the project purely as an experimental one. There had to be practical purposefulness behind it, and that could only be the demonstration that, in spite of prejudices, apathy and obvious difficulties, it is within the realms of practicability entirely to eliminate smoke production over large areas of our cities and to show that the town sponsoring the demonstration could be the greatest benefactor. Therefore it would be essential eventually to prove whether or not reduced pollution in the chosen areas really did take place as a result of their smokeless operation.

Selection of the Area or Areas

Although the " Simon Committee " had expressed the view that different types of smokeless zones were desir-

able in order to gain experience, it had always been accepted that the commercial centres of towns were most readily convertible to smokeless operation, inasmuch as they were already largely so. Those who know the city are aware that it contains no clearly defined commercial area, at least none sufficiently large to be of practical value for the purpose in mind, and then again, Manchester, the sister city, was contemplating applying the principle to a large part of its commercial area. Why not treat a different type of area, residential for instance, so that eventual comparison of results and experiences in differing types of fairly adjacent zones could be available for future guidance?

It so happens that prevailing winds in Salford veer between S.S.W. and W.S.W. and in the western portion of the city are the newer residential areas developed between the two wars, further development continuing recently, the areas being now almost built up. Much of the property is Corporation-owned and some of the houses equipped with "approved" solid fuel burning appliances. Hard by are the few areas in the city for public indulgence in outdoor recreative pursuits: parks, playing-fields and the like. Other ideals apart, to preserve



Proposed Smokeless Zones in Salford

them as much as possible from the effects of smoke is a worthy motive, whilst smoke produced in the west disperses over the remainder of the city.

Delineation of boundaries for three possible zones, with the Corporation estates forming their nucleus, revealed their alignment to be roughly directional with that of the prevailing winds. It is not easy to say if that was the deciding factor, but bearing in mind the influence of air-currents, it was envisaged that by choice of those three areas the greatest benefit was likely to accrue to Salford residents themselves and results more conveniently and effectively checked up on. Three zones were decided upon instead of the one at first visualized.

With the enlisted advice of the Department of Scientific and Industrial Research, five sites were selected inside or near the zones for smoke concentration recording stations, each being equipped early in 1949.

Smoke concentration is estimated by passing a known volume of air through a white filter paper daily, the resultant stain being matched against a set of standard stains calibrated at the National Physical Laboratory. Ultra-violet light is measured by the Ashworth U.V. Meter and checked against another at Ringway Airport where pollution is much slighter. The disposition of the stations encourages the hope that long term observation records will yield data supporting the theory that most improvement is likely to occur within the zones, the most southerly station, where a standard deposit gauge and a sulphur dioxide bubbler are also installed, providing, within limits, an index to variations in smoke infiltration.

Survey of the Premises

Meanwhile survey of premises in the three areas occupied several months. Its purpose was to classify the premises and to ascertain the appliances in use and the fuel used, particularly the amounts of different types of solid fuel. At the same time the general attitude to the proposal was noted and it was gratifying to find a general expression of approval for any scheme to reduce the amount of smoke in the atmosphere. Householders were anxious the scheme should not involve them in heavy expenditure on new heating appliances, but many were prepared to pay slightly increased prices for good fuel.

Included in the three zones of 750, 320 and 160 acres are three public parks (2 large, 1 small) 2 large areas of playing-fields ; a school-children's football, cricket and athletic ground ; a golf course ; a horse race-track ; as well as Kersal Moor, the highest point in the city, still preserved in its natural state as a public open space. Predominantly residential they contain 3,260 privately owned and 1,753 local authority owned dwelling-houses burning 11,266 tons of bituminous coal and 1,368 tons of solid smokeless fuel annually. The houses vary from 2-up, 2-down cottages to large high class residential property. Solid fuel appliances consist of 12,989 open grates, 322 closed or closable grates, 3,632 old type ranges, the majority of which are not used as such—cooking being by gas or electricity—912 modern ranges and 1,256 independent domestic boilers, but no independent cookers. "Approved" appliances number 338 space heaters and 200 independent water heaters, 189 of which also act as space heaters. The old type washing copper has to all intents and purposes disappeared, but a few still remain, many of them only because they are landlords' fixtures. Few are ever used however and most of the open grates are only occasionally used, some, particularly those in bedrooms, never.

With the exception of five industrial steam raising plants, 3 already using smokeless fuel and one preparing to convert, probably to gas, the remaining miscellany of premises in the zones, numbering 89, consume 98 tons of bituminous coal, 720 tons smokeless solid fuel and 6,750 gallons of oil each year. The other two steam raisers use 19,200 and 700 tons of bituminous coal and both can justifiably claim exemption from inclusion because of the efficient combustion and for practicable and financial reasons.

Fuel

The total quantity of smokeless solid fuel required to replace the bituminous coal now used domestically approximates to 12,000 tons annually. The all-important question—" Is the fuel available?"—was uppermost for a long time. Advices from reliable sources revealed the unexpected and pleasing fact that the additional demand could be more than met without infringing on supplies elsewhere. It is probably general knowledge that surplus accumulations of coke were only reduced last winter by an export drive. Much of our best coke was shipped to Scandinavia, but a suplus still exists. How can the allegation of non-availability be substantiated?

But coke is not the only smokeless solid fuel available. There will be a free market within the zones for the whole range of solid fuels with a volatile content below 15 per cent.

The view is taken that all the existing solid fuel appliances are capable of burning smokeless fuel, though it is frankly admitted that the newer types—those specifically designed for the purpose—will produce a more attractive result and reduce fuel consumption when properly used. The use of a blended fuel consisting of coke and low temperature carbonized fuel in proportions to suit individual requirements is recommended for general use. The effect will be to keep fuel prices near those of good house coal which has greater heating propensities but less *usable* heat, and obviate the necessity to replace existing appliances.

Appliances

At the proper time householders will be advised to select one of the tested and " approved " types when contemplating installation of new appliances. Those with loose stool-bottom grates will be recommended to exchange them at the first opportunity for simple coke burning units of the inset type now being sold and fixed complete with gas ignition by the North-West Gas Board on hire purchase terms as low as 7/3d. per quarter for five years.

Nowadays it is almost impossible to obtain spare parts from stock for Lancashire and Yorkshire ranges and special castings are extremely costly. Owners will have their attention called to this fact. There does not seem any sound reason for effecting expensive repairs to an already out-of-date fitting. Were the house being reconditioned replacement by an " approved " solid fuel appliance would qualify for Government subsidy. Many far-sighted and house-proud tenants would snatch an opportunity to discard the old unsightly coal burning range with its weekly " blackleading " and heavy fuel consumption if the owner would only pay the installation costs of a tiled surround and modern grate. Tiled surrounds can now be purchased on easy terms. As already indicated many now rely on gas or electricity for cooking and clothes washing but still retain the old range for space heating and domestic hot water, ignoring the brick built washing copper completely. The Housing Manager is impressed with the financial aspect of replacing the repair scheme by a programme for replacement of old ranges.

The object in smokeless zones is to eliminate smoke production to the limit of practicability. It is therefore necessary to face up to the problem of ignition smoke from smokeless fuel. True the quantity is nothing like that from coal, but administration difficulties will only arise if its production is permitted. Gas ignition is essential in avoiding ignition smoke and eases the difficulty associated with lighting the fuel.

Under Salford's Act the local authority is empowered to " contribute all or part of the expense necessarily incurred in executing repairs, or in providing, altering or adapting any fixture, fittings or appliances to comply with the provisions of an Order." It is therefore part of the scheme to contribute to the cost of providing gas ignition whether direct to the appliance or to a point near enough to permit the use of a gas poker. Cost in most cases is estimated at three pounds. The Corporation can contribute half the cost

up to a maximum contribution of two pounds.

From an early stage contact has been maintained with the local coal dealers so that they would be conversant with every development of the scheme and be in a position to prepare well ahead for its launching. It enabled them to table their difficulties, but more important still they realised that a greater interest must be displayed in smokeless fuels. They were quite anxious to cooperate, especially when it became known that fuel distribution would remain in present hands. Their feeling appears to be that smokeless heating of domestic premises is bound to increase and that it will be hastened through the establishment of smokeless zones. From their viewpoint it is better that solid fuel appliances be retained.

Other organizations who have assisted considerably with advice are The Coal Utilization Joint Council, The Low Temperature Coal Distillers Association and the Solid Smokeless Fuel Federation, and these organizations are ready to provide further assistance in practical form once the order has been confirmed.

THE USE OF SMOKELESS FUELS AS A CONDITION OF TENANCY IN LOCAL AUTHORITY HOUSES

By Alderman J. Robinson, J.P., M.D., M.Sc., D.T.M. & H.
(Stretford Borough Council)

Purpose

(*a*) To minimize atmospheric pollution in residential neighbourhoods by that due to domestic fires, and (*b*) to avoid increasing the general atmospheric pollution in an urban and residential area.

Direct Benefits from the Exclusive Use of Smokeless Fuel

(*a*) Less cleaning and washing, destruction of curtains, fabrics, paint, stonework, etc.: injury to plant life and loss of sunshine and brightness.

(*b*) Much more efficient (up to double) warming of houses for the same fuel cost.

(*c*) Better health—compare the lungs of a city-dweller, which are nearly as black as those of a coal miner. There is in the medical profession great apprehension of the causation of lung cancer by the inhalation of tarry fumes.

(*d*) Fuller use of rooms, *e.g.*, by older people and by students.

(*e*) Better heating of bedrooms.

(*f*) Easier use of wall-fires in bedrooms, with better control and more efficiency.

(*g*) The effective control and reduction of *domestic* pollution of the atmosphere gives grounds and justification for pressing for the reduction of industrial pollution and for the ultimate elimination of both.

Comparison of Fuel Consumption in Space Heating

Observations made in raising the temperature of a room by 4° F.:

(*a*) Coal burning with full draught in 48 minutes, using $3\frac{1}{4}$ lb. of coal.

(*b*) Electric fire (1 kilowatt) in 20 minutes.

(*c*) Coke (burning for approximately three hours before the test, but with damper closed), with damper opened—in 35 minutes, with an additional $1\frac{1}{2}$ lb. of coke, of which only approximately 75 per cent. burned.

Fuel Economy

It is reliably computed that as against a usual fuel efficiency of only about 20 per cent. for coal in ordinary coal grates, etc., an efficiency of between 30 and 50 per cent. can be obtained and maintained with better designed grates for

ordinary smokeless fuels, and this means cheaper and more heating, with less damage and loss from the wasteful consumption of fuel.

Corporation Houses built in Stretford since 1945

(*a*) All, with the small exception noted later, have fireplaces for the use only of smokeless solid fuel for cooking and water-heating, etc.

(*b*) No fireplaces are installed in sitting-rooms and bedrooms.

(*c*) These rooms are fitted with electric or gas wall fires.

(*d*) There are smaller and cheaper flues for combustion gases and ventilation.

(*e*) Fuel consumption is lower, and cheaper, for the same result.

(*f*) Coke has been readily available.

(*g*) About 10 per cent. of the tenants dislike the system ; about 50 per cent. use coke exclusively, and about 40 per cent. mix some coal with the coke on occasion. There is a serious disadvantage in mixing coal with coke, as with the draught necessary for burning coke, clinkering and damage to the firebars readily occurs.

(*h*) An exception was made in the case of an estate of 38 bungalows for aged people, where ordinary coal grates were fitted.

Statistics as at September, 1950

Total number of houses in the Borough—private and Corporation-owned—approximately 17,500.

Houses fitted with only smokeless fuel grates, approximately 3 per cent.

Total number of Corporation-owned houses, 2,568.

Houses built or rebuilt since 1945, 581.

Houses with only smokeless fuel grates, 543.

Proportion of Corporation-owned houses so fitted—21 per cent.

Proportion of post-war houses fitted as above, approximately 93 per cent.

Further houses in present contracts to be so fitted, 180.

The Use of Smokeless Fuel

When the proposal for the exclusive installation of smokeless fuel apparatus was first made, it was met with some objections and forebodings of trouble, as indeed all innovations, however beneficent, are met.

However, since the initial difficulties have been overcome and its use has become familiar, *it has been possible to impose as a condition of tenancy the exclusive use of smokeless fuel*—which in practice means coke.

It is probable that the prevailing housing shortage has greatly minimized the reluctance of prospective tenants to accept the innovation.

It must be recognised that the full enforcement of the condition may continue for a time at least to be somewhat difficult.

To popularize the idea, the following points are noted for attention :

(*a*) There were early difficulties, soon overcome, in the correct building of the flues.

(*b*) More use of additional flues and convector panels for background heating.

(*c*) Procuring Government subsidies for the cost of changing-over existing houses to smokeless fuel grates.

(*d*) Townships should by degrees establish smokeless zones, as Manchester and Salford are doing.

(*e*) The installation of smokeless apparatus as a condition of the grant of subsidy.

Auxiliary Measures

With the co-operation of the Borough of Sale and the Urban District of Urmston, Stretford has set up a series of about 25 posts for the systematic measuring of atmospheric pollution. The present rate is high, and recently very extensive oil-cracking plants have been established on our windward side. Nearby a great new electricity station, which is to use 8,500 tons of coal a week, is being set up. Already representations to the Central Electricity Board have elicited an undertaking that, contingent on proof of damage by increased atmospheric pollution, plant will be installed to ensure its elimination or its reduction to the lowest possible extent.

Other Methods to be Used in the Achievement of Clean Air

(*a*) The adoption of this procedure (or a similar one) by all local building authorities.

(*b*) The extension of the method to *all* post-war houses, private as well as publicly owned.

(*c*) Education of members of local authorities and of housing committees to the needs and possibilities.

(*d*) Education of householders and the community generally.

(*e*) Education of school children and teachers.

(*f*) Demonstration in health exhibitions, e.g., in public libraries.

(*g*) Local observations of atmospheric pollution like that described in the preceding paragraph—and comparisons with cleaner places.

(*h*) Legislation requiring the elimination of smoke production in all new houses first, and then in existing houses—possibly with a subsidy in the latter case; and giving local authorities powers and obligations for the setting up of smokeless zones and their gradual extension.

(*i*) It should then be possible to recruit people who have so long suffered, even if often unconsciously and without resentment, from the toxic and destructive effects of the wasteful use of fuel, to active support of measures for the complete removal of this so resistant an evil.

Acknowledgments

Mr. A. H. Perry, Borough Surveyor, Stretford.

Mr. H. P. Brown-Poulton, Estates Manager, Stretford.

Dr. J. L. Burn, Medical Officer of Health, Salford.

Housing Manual, 1944, Ministries of Health and Works.

Domestic Fuel Policy, Ministry of Fuel and Power.

National Smoke Abatement Society—many publications.

THE SOLID SMOKELESS FUELS SITUATION

Report of an Inquiry by the Society's Publicity Committee by F. J. Redstone, F.R.San.I., F.S.I.A., Chairman of the Committee

It will be recalled that at the Harrogate conference last year a resolution was passed urging local authorities to encourage the use of solid smokeless fuels in houses equipped with the new, approved appliances, which are suitable for these fuels. The resolution was duly submitted to the 1,740 local authorities in Great Britain, of which about 100 replied or discussed the resolution with the Society. This is a small proportion of the total, but no specific reply was asked for, and it is known that many other authorities considered the resolution.

An examination of this limited number of replies and the general tenor of comment on the resolution, which was shown also by fifty press reports of Council discussions, revealed a disturbing lack of interest and understanding, by some authorities, of the nature and value of solid smokeless fuels for domestic use. To what proportion of authorities this criticism applies is not known, for our information is so incomplete; but as far as we can judge it is substantial.

It is fully appreciated that there have been, and still are, many difficulties in the way of extending the use of solid smokeless fuels by substantial amounts and since the new appliances began to be installed in new houses it has been inevitable that many of them should, for the time being, have to burn

bituminous coal. These appliances are nevertheless more efficient with smokeless fuels, and if we are to achieve domestic smoke prevention in our time we must press on more vigorously with the programme that has been advocated by the Society and was recommended in the Simon Report on "Domestic Fuel Policy." The implementation of this policy must be gradual and progressive, and must be based not only on the availability of suitable fuel at a suitable price, together with the installation of the new types of open fires, stoves and boilers, but also upon a campaign of publicity, explanation and encouragement, in which the local authorities must play a leading part.

The solid smokeless fuels upon which progress must depend—we are not considering on this occasion the parts to be played by gas, electricity and district heating—fall into three main groups. First, there is anthracite and the other low-volatile smokeless coals from South Wales. Then there is gas coke (and locally, some coke from coke ovens), and finally the semi-cokes sold under trade names and produced by the distillation of coal at relatively low temperatures.

Anthracite and the other natural smokeless coals are available to a limited extent only because of their high export demand—they help to buy our Canadian bacon, for instance—and it is unfortunately improbable that much more can be diverted in the near future to the domestic home market. There is much room for the development of the low temperature carbonization processes, but the amounts of these fuels, such as "Coalite" and "Rexco" are at present limited and fully taken up, and the expansion of production we may hope for must of necessity take time. Gas coke, on the other hand, is manufactured in considerable quantities throughout the country, and is at present in such good supply that it has been freed from all rationing control. It is through the wider use of coke as an open-fire fuel, and for boilers and stoves, that we can make the earliest and most substantial progress.

The replies from local authorities showed, however, that in many cases little or nothing is being done to encourage, let alone require, the use of coke or other smokeless fuel. In only one instance, which we have heard reported during this session, was any attempt being made to ensure that nothing but smokeless fuel would be used. In other cases, smokeless fuel would be required when proposed smokeless zones were established.

In some instances, local authorities appeared to wish to take action, but felt that they could not do so because of difficulties in distribution, price, or, in the mining areas, because of the special problem raised by concessionary coal. In many cases, however, it was apparent that the value of coke as a domestic fuel was not appreciated as it should be. This is in part a regional problem, dating back for many years, and which makes all the more necessary, in what we may call the backward areas, the campaign of explanation and propaganda already mentioned. It was also indicated, but perhaps only with reference to certain areas and certain grades of coke, that the quality of the fuel met with some criticism.

The position to-day may be summed up by saying that although the new appliances are proving themselves to be satisfactory, and although gas coke, even if not the other smokeless fuels, is at last easy to obtain, there are still many difficulties to be overcome. Progress is indeed being made, yet many opportunities are being lost, new areas of smoke pollution are coming into being, and only a fraction of what could be done by local authorities to encourage smokelessness, is in fact being done.

Deputation to the Gas Council

The Publicity Committee was requested by the Executive Committee to examine the situation, and as a result a deputation from the Committee met Col. H. C. Smith, Deputy Chairman of the Gas Council, to urge examination of the price, quality and distribution of coke, and to express the Society's hope that it would be possible to give more publicity to popularize it.

The deputation was assured that the

Gas Council and the Area Gas Boards were anxious to do all that the Society wanted, but they had many problems to solve. With regard to price, coke was being sold at prices determined by the Ministry of Fuel and Power, and any reduction could be made only by raising the price of gas, which was an equally important smokeless fuel. In many areas the price of coke was virtually less or the same as good house coal, while on an effective heat basis its real cost was the same as coal if their prices were in the ratio of 101/- for coke to 90/- for coal.

On distribution, arrangements were being made in some areas with the fuel merchants for more favourable selling margins, which would help to encourage the sale and improve the distribution and availability of coke. It was hoped that these new arrangements would be extended to other parts of the country.

It was agreed that the quality of coke varied considerably, and that the industry was fully aware of the need to secure improvements. The quality of coke depended, however, mainly on the quality of the coal from which it was produced, and was part of the general problem of coal quality.

On education and propaganda to popularize coke, and in some areas to secure its better acceptance as a fuel comparable in quality with coal, it was stated that the Gas Council was anxious to develop a campaign of the kind urged by the Society, but until the problems that had been discussed were more clearly on their way to solution it would be unwise to do so in all areas. Nevertheless, plans were in hand for a publicity campaign, which included a film, film flashes, posters, layouts and leaflets. The campaign would be operated by the Areas Boards to suit their individual needs. The need for publicity among local authorities, as suggested by the Society, was appreciated and would be borne in mind. It was emphasized that the use of coke for domestic purposes, and the public attitude towards it, varied considerably from one part of the country to another, so that to a certain extent the matter had to be considered on a regional rather than a national basis.

The Semi-Cokes

Although attention has been given almost entirely to gas coke in this review, mention should be made of the low temperature carbonization fuels or semi-cokes. Numerous processes have been devised for treating coal in this way, and several have been operated on a commercial scale in this country. The most successful, and best known, is of course the "Coalite" process, and we are glad to learn that work has begun on long-term schemes of reconstruction and modernization, and that this will ultimately result in progressively increasing rates of annual production. Increasing production to the limit of availability of suitable coal supplies, it is stated, does not present any technical problem, but, until the National Coal Board have completed their work on the preparation of a price structure, it is not possible to give an estimate of the contribution that the low temperature carbonization industry can make towards the solution of the long-term problem.

Whereas the "Coalite" process makes use of small coal, the "Rexco" process was particularly designed to use nut-sized coal, which means that the original capillary structure of the coal is preserved and a dense, hard fuel is produced.

It is outside the scope of this short report to discuss the properties and special advantages of the low temperature carbonization fuels, coke, the natural smokeless coals and the manufactured smokeless ovoid fuels such as "Phurnacite." This can best be done by those directly concerned with the fuels, and it is hoped to publish a series of illustrated articles about them in *Smokeless Air*. Such a series would be especially interesting and useful at the present time.

DISCUSSION ON "NEW HOUSING" PAPERS

The Chairman, Dr. Harold Hartley, in opening the discussion, said that if means could be devised for eliminating smoke from the domestic chimney, a great step forward would have been taken towards the ideal of the smokeless city. The authors in their papers had reminded them that they had available anthacite, coke, and steam coals. They had made reference to the existence of fires, cookers and water heaters, of a variety of designs suitable for use with these fuels. They had also mentioned that the amount of bituminous coal burned in the home still exceeded greatly the weight of smokeless solid fuels. In fact there was not as yet available enough smokeless fuel to replace all the bituminous coal burned in our homes.

Of late years a great deal of work had been done to develop domestic equipment with which the necessary work could be carried out at a much higher efficiency than was the case in the past. One author had mentioned that with modern appliances the fuel consumption could be halved, although in actual practice it was not found that this happened, because users tended to raise their standard of comfort. There was an obvious need for apparatus which would burn bituminous coal smokelessly, and a good deal of work was now concentrated on finding a solution for the problems involved.

From the point of view of smoke elimination it was unfortunately not enough to install a piece of apparatus designed for the burning of smokeless fuels, as such apparatus would in many cases work satisfactorily with the bituminous coals, and there would still be much to be done, were adequate smokeless fuel supplies available, to presuade British householders to stop burning coal.

So far no one seemed to have succeeded in designing an open fire in which coal could be burned smokelessly, although some reduction in smoke production had been effected. More effort should be concentrated on this matter by appliance manufacturers, who would feel a greater urge to do so in the future as the smokeless zone concept is developed.

The standards of comfort provided by houses erected in the post-war period were much higher than were attainable in the same class of property in the past. Quite a number of openable stoves had been installed, and if this trend grew the problems facing the appliance designer might be simplified a little when endeavour was made to bring about smokeless burning. Be that as it may, the increase in popularity in that class of apparatus was a welcome sign.

A. C. Hazel (Coalite and Chemical Products Limited), in congratulating the speakers, also thanked them, and in particular Mr. Redstone, for the encouraging remarks he made regarding the "Coalite" process of low temperature carbonization.

Mr. Hazel stated that in view of these remarks, the Conference might like to know that his Company had increased the production of "Coalite" by 18 per cent. in the past 15 months. However, the future progress depended to a very great extent on the price of coal, and he was most interested in the remarks made by Dame Vera Laughton Mathews in her Presidential Address, when she suggested to the National Coal Board that they might consider increasing the price of bituminous coal supplied for use for domestic purposes, in view of the damage the burning of this raw coal did to the community at large, and reducing the price of coal to those organizations which produced smokeless solid fuel.

Mr. Hazel mentioned that another way of encouraging manufacturers of smokeless fuel would be to remove the 9d. per gallon new Excise Duty on indigenous fuels. He pointed out that as far as his own Company was concerned, the removal of this Excise Duty would mean a reduction in the price of "Coalite" of 5s. per ton.

Mr. Hazel said that, speaking personally, he had heard that if the price of bituminous coal for domestic purposes

was increased by 6d. per ton, it was possible that the price of reactive cokes might be reduced by anything up to 1s. 6d. per cwt.

However, it was a little difficult for a person in his position to comment on these points, though he was very interested indeed in Dame Vera's suggestion.

A great deal had been said by various speakers about the Simon Committee's Report, and Mr. Hazel wondered what had happened to this Report. The Ministry of Fuel and Power had appointed a Fuel and Power Advisory Council consisting of very eminent people to report on domestic fuel policy, and their chief recommendation was that the main winter space and water heating load should be undertaken by smokeless solid fuel, which was obviously in line with the views of the Smoke Abatement Society.

Nearly three years had elapsed and nothing had been done about it. Could not this Conference, celebrating its 21st birthday, draw the attention of the Minister by telegram to the fact that delegates were seriously concerned at the delays in the implementation of this most important Report?

J. S. Williams (Director of the Coal Utilisation Joint Council) said that his Council—which wholeheartedly supported the smoke abatement movement—had recently been giving a great deal of thought to the problems likely to arise from the creation of smokeless zones.

The elimination of domestic smoke could be achieved in three ways; by an extension of the use of gas or electricity, by the use of solid smokeless fuels, or by burning bituminous coal smokelessly. It was recognized, however, that it would be impracticable for gas and electricity to supply the whole domestic load, as this would raise at once the question of peak loads and the cost to the consumer. Moreover, it would be at direct variance with Government policy that in the national interest the main winter domestic heating and hot water loads should be borne by solid fuel.

Of a total domestic consumption of some 35 million tons of solid fuel a year, only 6 million tons was at present smokeless solid fuel, and the remainder was bituminous coal. The Council had been given to understand that, for the next five years or so, there would be little hope of additional supplies of the natural smokeless fuels, such as anthracite and dry steam coal, and that the prospective increase in the supply of carbonized smokeless fuels was only likely to be to the order of a few million tons. This increase could make no appreciable contribution to replacing entirely the 29 million tons of bituminous coal at present used in the home—and even this tonnage was restricted by reason of today's difficult supply conditions.

With this big gap between the possible supply of smokeless fuels and the total domestic demand, it would seem that the ultimate solution to the problem of domestic smoke abatement lay in the progressive development of appliances capable of burning bituminous coal with less and less smoke. The evidence available at the present stage of research, however, was that the burning of bituminous coal completely smokelessly in the open grate, which was the crux of the problem, was not likely to be achieved for many years.

The Council's fear, therefore, was that if a general movement developed to establish smokeless zones throughout the country, there would be neither sufficient quantities of solid smokeless fuels nor of appliances capable of burning bituminous coal smokelessly. In the result, the smokeless zone movement might well be discredited. If the present supplies of solid smokeless fuels were to be used to best advantage in the interest of smoke abatement, it would be better if certain of the new towns or re-development areas declared their intention of being "cleaner air" zones. A new town started clean and it would seem right and proper to keep it so; this could be done at little expense as the new houses could be equipped from the start with suitable appliances.

In other areas, the Council suggested that local authorities should accept initially a less stringent standard than

the absolute smokelessness required under the present Corporation Acts. An advancing programme, by which the better and cleaner appliances which were now available were widely installed, would secure an ever increasing measure of smoke reduction over the country as a whole, which would be a much more practicable contribution to smoke abatement than the piecemeal introduction of a number of isolated smokeless zones with all their attendant difficulties of fuel supply.

Councillor C. E. P. Stott (North West Area Gas Consultative Council) stated that he represented the North Western Gas Board and he congratulated Alderman Goulden on the contribution made to the Conference and particularly his demand that the problem of coke consumption should be brought within the understanding of the housewife.

The North Western Gas Board were spending £1,000 per week in advertising the use of coke and gas, and last year the Gas Board had sold 15,000 coke grates and anticipated selling considerably more in the current year. The coke grates were available on the hire purchase system at a charge of 7d. per week, which included installation.

From a psychological point of view, it was desirable to sell coke cheaper than coal as the average domestic consumer looked upon coke as a kind of cinder left after coal had been utilized. He was aware that the calorific value of coke and good household coal was the same but only experience would prove this fact to the housewife. In his opinion, it was undesirable to negotiate with the Gas Council in regard to the question of coke. The Gas Council had no part to play in the production or distribution and all negotiations should proceed through the twelve undertakings which were autonomous.

At one time, the gas cooker was unfamiliar and unpopular but today there was a queue of women waiting to secure gas cookers. By demonstration and propaganda, the present unpopular coke could be translated to a like popularity with a queue demanding service.

P. H. Saunders (Chief Smoke Abatement Inspector, Liverpool) said he thought the cost of smokeless fuels was the deciding factor in overcoming the problem of domestic smoke. In Liverpool gas coke which has been found to be suitable for the domestic open grate, and which is in plentiful supply, is sold at something like 55s. per ton and this no doubt accounts for the many conversions from raw coal burning.

He was certain that if domestic coke could be made available at 55s. a ton in all large towns it would become the most popular fuel for the many thousands of existing open fireplaces and would bring about a considerable reduction in pollution of the atmosphere.

Mrs. I. Heppleston (Wakefield Rural District Council), who was a delegate from the West Riding of Yorkshire Smoke Abatement Committee, spoke of the various ways in which the pollution of smoke and fumes affected the housewife. She gave personal experiences regarding her own home and locality and the troubles brought on by the use of bituminous coal. Councillor Mrs. Heppleston thoroughly approved of the better conditions and modern machinery already being experienced by the miners, but she appealed to the officials of the National Coal Board to go further and install cleaning plants for the raw coal and a more modern method of boiler stoking, so as to reduce the amount of smoke and grime which belched forth from the colliery chimneys, thereby polluting the countryside. Her final words were to the housewife to get together and try in some small way to clean up these dark spots of which our country has many.

D. G. Rose (Coke Manager, North Thames Gas Board) said that three authors introducing their papers appeared to ask for reässurance as to the adequacy of supplies of solid smokeless fuels, and the matter had received further attention in the discussion, one speaker having suggested that the problem was of such magnitude as to call for "moderation."

Speaking for the coke side of the

Gas Industry, Mr. Rose said that in his judgment there was nothing in the present or forward position that should occasion any moderation in the efforts of the Society. There were problems, of course, but many of the difficulties that had been mentioned were essentially matters of distribution. The Gas Industry had these well in hand, however, and he felt sure that Councillor Lancaster and Alderman Mrs. Engwell, who had spoken of deficiencies in two London boroughs, would find a considerable improvement during the coming winter.

James Law (Sheffield), in a written contribution said it was very disappointing to note that in all five papers submitted no word of encouragement of any kind was given to District Heating. Most of them were agreed that such a method was ideal and their only misgivings are regard to cost.

Mr. Turner's statement on possible costs of District Heating appeared to be contradictory for he stated that " there is a paucity of *reliable data* on which to place reliable estimates," then later stated " after a careful consideration of the *available data* the Corporation do not consider the very large investment would be justified—and that other Corporations are reaching the same conclusion."

He would like to ask Mr. Turner what data had been considered and if he had had a detailed scheme prepared and costed or was he judging from the uncomplete data so far available from the schemes that were as yet in their initial stages? He mentioned Dagenham and the figures shown by them appeared to contradict his pessimism on this matter.

In discussing the various schemes that were in operation, it was understood that at least four of them had been curtailed and the general policy changed almost out of recognition.

Those that were operating were doing so on temporary plant. Even with these handicaps, the highest costs compared with traditional methods, at the same time giving increased service. On the better schemes, it was understood that the costs were below normal and the most important feature was that *Smoke had been practically abolished* in those areas.

It was felt that this matter had had too scanty consideration and it was the duty of the New Towns Corporations to investigate the matter much more closely than had been done and to publish the figures.

The figures given recently in a report on District Heating in American Housing were startlingly low. Surely, if the Americans could achieve such economical results there should not be any difficulty in the engineers of this country doing the same?

Donald V. H. Smith, in a written contribution, said that owing to the large number of speakers at the discussions on Housing and the New Towns, he was not fortunate in being able to add a few words. Mr. Turner's general statement of the problem was admirable, but he could not let some of the statements pass without comment.

He stated " there is a paucity of reliable data on which to base estimates of capital and working costs," and also " after careful consideration of the available data, the Crawley Corporation did not consider the very large investment which would be necessary, would be justified."

The conclusion indicated in respect of Crawley might or might not be justified, but he submitted that any such general conclusion was premature without fuller investigation of data of schemes in progress.

The plain fact was that District Heating had so far, in Great Britain, never had a fair chance. Even many of the schemes in progress had been badly curtailed *after commencement*, thereby greatly increasing the incidence of fixed charges per dwelling.

In spite of that, and despite some small teething troubles that have been over publicized, much of the data already available conveyed an encouraging impression. Admittedly, the final picture was not yet complete for full guidance and general publication, and he would suggest that until it was judgment should be suspended.

The fuel position was so precarious that any method that could give a better

service at the same, or even lower, fuel costs, must be even more closely examined than had been the case so far, and he did not despair of this country being able to emulate and at least equal what so many other countries had done in this direction.

Cyril H. Walker, replying to the discussion, said that the use of smokeless fuel was largely one which was determined (i) by the efficiency of the fireplace (which must be of special design), and (ii) by educating those we expect to use the apparatus in the proper use of fuel—subject to there being sufficient storage space at the premises for the additional bulk, and to the suppliers being prepared to reduce their prices, temporarily maybe, to encourage people to burn the fuel; and lastly to there being ample supplies.

He was not at all sure that to say the demand for smokeless fuel would outstrip the supply was a good reason for going slow. The obvious answer, it seemed to him, was that more use could be made of the by-products by a proper coking of coal than by permitting its by-products to waste in the air and encourage smoke nuisance.

Insofar as an apparatus that would use ordinary coal in a smokeless way, and with high efficiency, was concerned, Mr. Walker thought that this would depend too much on efficient stoking to be reliable; and it was therefore for the industries concerned to see that supplies of smokeless fuel were available.

With regard to Mr. Smith's written contribution, it was a fact that the figures concerning Dagenham were correct, but he could not agree that there would be any substantial saving in maintenance costs on the property. In his experience this had not been so, although, of course, there were some slight savings which, if one was not careful, might be offset by additional maintenance costs elsewhere. The experiment was an excellent one, and he thought possibly the Society might like to inspect the joint efforts of Dagenham and themselves at a later date.

F. J. Redstone said that as chairman of the Publicity Committee he would like to get in touch with every one in the country who had the enthusiasm displayed that morning by Alderman Goulden.

It was undeniable that progress was being made by the Society in securing cleaner air, and this was no doubt being brought about by a process of "gradualism." The tenacious attitude of the Society in furthering its aims was bringing recognition and this was evidenced by the programme and material submitted to this Conference.

He agreed with Alderman Mrs. Engwell (Barking) that the Society had been remiss on this occasion by its failure to more adequately present the women's point of view from the platform and this would be kept in mind for next year's proceedings.

C. A. C. Turner, in reply, said: I am very glad to have this opportunity of replying to the written observations by Mr. James Law and Mr. Donald V. H. Smith submitted to the Society after the conclusion of the Conference at which my paper on "Smoke Prevention and the New Towns" was discussed.

Before investing the very large sum of money required to develop a comprehensive district heating scheme for a town, the developer must consider not only estimates of capital cost but the extent to which the product will be marketable both in good times and in bad over a substantial period of years.

In many parts of America and of Europe the normal winter temperatures are so low that living is impossible without the comfort of substantial artificial heat. The occupant is compelled to provide this heat over periods of three or four months every year, either by means of the extensive use of solid fuel or the introduction of a central heating plant in each dwelling. Under these conditions the annual cost to which each individual is committed is substantial, and the investor in a district heating plant can assume that practically the whole of the inhabitants of such areas will purchase heat from his central plant at a lower cost than they could provide a similar standard of heat themselves. In England these condi-

tions do not prevail, and in many winter seasons perfectly adequate comfort can be secured from a relatively small outlay in solid fuel, gas or electricity. In these circumstances, heating to the American or Continental standard becomes a luxury and not a necessity, and will be used only if the family budget permits of this expenditure without depriving the individual of other luxuries or even necessities which he values more highly.

The capital cost of district heating must be incurred virtually in its entirety before the scheme is put into operation and the capital charge and maintenance must be defrayed by the developer in perpetuity.

Under English conditions it is probable that in a slump large numbers of people would terminate their agreements at the shortest period possible, and would thereafter depend upon the use of gas or electricity. It is well known that the widespread use of electricity for domestic purposes, especially when used intermittently, has already caused embarrassment in a country in which the generation of electricity is costly. If this were further aggravated in a period of slump, there would be far-reaching consequences to the electric supply throughout the country.

District heating must be considered in the dual capacity of heating and hot water services. The hot water service is far more economical provided by local appliances without the very heavy loss on street mains ; and this virtually eliminates the provision of district hot water.

In the English climate, humidity of the air makes high temperature heating in dwellings much more uncomfortable and less readily acceptable than in a country where the air is dry, and English heating schemes are run at lower temperatures. It is almost universal to find that the Englishman augments the heating from local electric sources, thus again adding to the undesirable load on English electricity.

The varying English winter makes the average expenditure on fuel over a series of years a factor which varies considerably and the householder will therefore go through some seasons during which his expenditure on fuel, if under his control, is light. Similar saving takes place when he goes for holidays, week-end visits or similar occasions. Even if the householder turns off the radiator heating, heat losses in the mains largely remain. Under these circumstances a steady commitment over a substantial period is almost non-existent in England and indeed in many periods the heating which the district heating provides is not required.

Recent legislation has caused embarrassment to all building owners who provide substantial services for their tenants, and in many cases has involved them in appreciable loss. Calculations so far made between the inevitable minimum running costs and capital charges of a central scheme compare unfavourably with the necessities of a household living within a modest income. This situation so far precludes consideration of district heating as an assured economic project.

(I) A STATEMENT OF THE PROBLEM

W. O. Skeat, B.Sc.(Eng.), A.M.I.Mech.E., M.I.Loco.E.

Introduction

It may take a million years to make a lump of coal. It can be wasted in a minute. Nearly all of us must, at one time or another in the past, have been guilty of some wastage of coal, however small. It is, however, with the railways, as one of the greatest users of this increasingly precious national asset, that we are concerned to-day.

A substance which has been so carefully and laboriously built up as a piece of coal deserves appropriately careful use ; quite apart from this, the feeling of pride in a job well done is an outlook which should be encouraged by the railway authorities to such an extent that every fireman on the road and every lighter-up in a running shed will feel a personal satisfaction in striving to attain the nearest possible approach to perfect combustion.

1. Historical Note

Mr. M. G. Bennett, whose report accompanies this paper, has already outlined some of the early circumstances which led to the abandonment of coal as locomotive fuel as early as 1826. Between thirty and forty years were to elapse (during which time coke was the universal fuel in this country) before engineers had solved the general problem of burning coal successfully in locomotive fireboxes. During the whole of this long period, constant efforts were made to use coal, especially by Joseph Beattie, J. J. Cudworth, and D. K. Clark. The first two of this trio made the fatal mistake of producing over-elaborate devices for incorporation within the general conception of the Stephensonian locomotive ; but in this respect they were in a goodly company, for even one hundred years later, this lesson still has not been learned. Their elaborate double fireboxes and feed-heating devices are now only of historic interest. The redoubtable Clark, however, came much nearer the solution, for his proposal was simply to fit over-fire air-jets, an idea which has been revived of recent years with much publicity on the other side of the Atlantic. It speaks much for the degree of insularity sometimes achieved by locomotive engineers in the past, that this simple device, though perpetuated for many decades on Clark's railway (the Great North of Scotland Railway) never became widely adopted. Probably it was regarded as an over-refinement.

But in regard to another development about the year 1860, which took place on the Midland Railway under Matthew Kirtley, there was no such insularity. It was widely and quickly perceived that by placing a brick arch in the position it now occupies, and by adding a deflector plate or "scoop" fitted inside the firedoor and pointing towards the arch, the whole firebox was divided into a lower portion (the furnace) and an upper portion (the combustion chamber). This was the ultimate solution to the problem which had confronted locomotive designers for more than thirty years, and an understanding of the excellent simplicity of the idea is essential, for, given the right conditions, i.e. suitable grades of coal, good maintenance of the locomotive, and adequate skill and discipline on the part of the fireman, it is undoubtedly possible to achieve almost complete combustion with no other aids. In fact it was probably a realization of this that made D. K. Clark's steam-air jets appear almost

unnecessary and prevented their widespread use.

Oil Fuel on the Great Eastern Railway

Mention should be made of the pioneering attempts made by the former Great Eastern Railway to substitute oil fuel for coal during the period 1889-1909. The motive behind this development was not, however, to find a substitute for coal but to find a use to which unwanted residue could be put. The oil, which was a by-product in the manufacture of gas for lighting railway carriages, was injected into the firebox by steam-operated injectors, and the device was most successful. It has often occurred to the author that more use might be made of this system of utilizing crude oils, where the economic conditions warrant it, since a very fine measure of control can be exercised over the combustion in the firebox—finer, indeed, than with solid fuels.

Present-Day Fuels and Prospects

To-day, however, the railways are at the mercy of the present conditions obtaining in the coal industry. They are by no means the only industrial users to suffer from the obligation to take what grades of coal are meted out to them, irrespective of their suitability. Thus we find domestic coal being delivered to running sheds instead of steam coal; while the present-day drive for mechanized coal cutting is resulting, as everyone knows, in an undue proportion of dirt being supplied. At the same time, mechanical handling devices are apt to treat coal roughly and to give rise to a high percentage of fine dust. All these factors have a bearing on our problem, because these mechanical methods have come to stay. A further circumstance is also to be noted: the best seams are naturally worked first; later on, attention is turned to the secondary deposits, so that we are tending all the while to produce coal of gradually lowered quality. These depressing conditions must be faced, however, if the smoke problem is to be overcome.

2. Sources of Railway Smoke

(a) Running Sheds

A locomotive when working a train that is properly on the move, if it has a capable fireman and reasonably good coal, should not make enough smoke to cause a nuisance. The author's present house overlooks a quadruple-track steam-operated railway, but the amount of smoke and smuts is infinitesimal compared with that in the Westminster atmosphere in which he lived from 1938 to 1946; indeed he has to record Westminster air as the most polluted in which he has lived for any length of time, yet no steam-operated railway was within a mile of his flat. It should be remarked here that the layman almost always refers to the exhaust steam of a locomotive as "smoke" and his ideas on smoke emission by locomotives are apt to be distorted accordingly.

But there is no denying the fact that the stables of the iron horse are in many cases approaching Augean conditions, and it is much to be hoped that the National Smoke Abatement Society can play the role of a modern Hercules in securing a thorough cleansing. The author feels strongly about this matter, for the railway steam locomotive, in his opinion, is one of the greatest of all man's inventions; it acquires a considerable glamour in the spectacular role it plays in our modern life, yet off duty it is housed in conditions which are absolutely disgraceful. Small wonder that recruitment into the various grades of running shed staff is difficult.

Apart from the poor physical condition of so many sheds, there is the problem of avoidable dirt due to inefficient methods of firing and lighting-up. Indeed, the smoke emitted from locomotives freshly lit up in running sheds is the most serious aspect of the whole subject of railway smoke. Many important sheds are not far from dwelling-houses and if these are to leeward, the inhabitants may well have cause for complaint. Since railways have to be worked twenty-four hours a

day, seven days a week, there will not even be an odd day or two when freedom from the nuisance can be expected.

Running sheds, then, must be counted as the worst sources of atmospheric pollution by railways, particularly when locomotives which have been out of service any length of time, and are therefore cold, are concerned. Three other places where railway smoke can be a nuisance remain to be mentioned: stations, shunting yards and tunnels.

(*b*) *Smoke Emission when standing in Stations*

A few days ago the author witnessed an everyday occurrence which nevertheless is typical. A cross-country train arrived at a large station where engines were to be changed. The engine which was to take the train onwards arrived in a convenient siding about 30 minutes before the train appeared. Not the slightest attempt was made during those thirty minutes to prepare the fire of the waiting engine for its forthcoming run; but after engines had been changed and the waiting engine had backed on to the train, the fireman started piling quantities of coal into the firebox till it was level with the firedoor; a vast plume of filthy smoke poured out and the blower had to be put on full, lifting the unburnt carbon some eighty feet into the air and giving it sufficient start to blow over against a row of houses alongside.

The cure for station smoke is preparedness, plus a judicious use of the blower and adjustment of the firedoor opening to make combustion as complete as possible.

(*c*) *Smoke during Shunting Operations*

The author thinks that complaints about smoke during shunting operations are apt to be exaggerated. During the actual train movements, the fire is generally kept fairly clean and as most shunting engines are small machines, the smoke created is not very bad, for in a little firebox the newly added coal is soon able to warm up and become incandescent. But in between the sorting of long rakes of wagons, shunting engines may be kept waiting about, either for movement across a busy set of main lines or queueing for visits to water cranes, and those are the times when the fireman is liable to fill up the firebox so as to save himself all possible effort during ensuing operations. The prevention of smoke here follows the same lines as smoke prevention in stations.

(*d*) *Tunnels*

Next to running sheds, tunnels are the smokiest spots on a railway. Tunnels are nearly always approached on either side by a stiff gradient which means that there is some heavy "collar work" to be done by the engine in lifting the train up to the summit. A late cut-off in cylinder steam has to be employed; there is a correspondingly sharp blast on the fire, and enhanced likelihood of all the finer particles in the firebox, burned or unburned, being carried through the tubes and ejected via the chimney. Tunnels can be pretty bad to the passenger; to the engine crews they are an utter abomination; to the civil engineer concerned with their maintenance they are a perpetual worry; and to those unlucky enough to live near their mouths or ventilation shafts they are an unmitigated nuisance.

The author finds it difficult to see how smoke nuisance in tunnels can be abolished, but it might be lessened by building more ventilation shafts, and the Railway Executive might consider the installation of large fans and washers in bad cases like the tunnels just outside King's Cross Station. In a few cases, tunnels have been abolished, being converted into deep cuttings where engineering and geological features permitted; this too is an idea which might be extended to a few other cases, since although the capital cost would be high, the subsequent reduction in maintenance would be very great.

The best that can be done in the circumstances is to approach the tunnel with a fire as hot as possible so as to avoid the need for firing just before entering it.

3. Railways as offenders in Atmospheric Pollution

(a) How do they stand compared with other sources of deposits?

Comparatively few statistics are available to show the degree to which railways alone are the cause of atmospheric pollution in various towns. The late Dr. J. S. Owens has given numerous data for mean monthly averages of total solids deposited, in tons per square mile, for various cities. The returns for 1936, which came to the author's notice in a paper which Dr. Owens presented to the Institution of Mechanical Engineers, may be taken as representative of the period between the two World Wars. They show a high level of 58.06 for Netherfield Road, Liverpool, to 24.35 for Golden Lane, London. Several large towns such as St. Helens, Stoke-on-Trent, and Birmingham, which have achieved some notoriety in atmospheric pollution in the past, showed intermediate figures.

Mr. M. G. Bennett, however, has given some useful guidance in the Report which he presented to the Joint Conference of the Institute of Fuel and the National Smoke Abatement Society. He referred to the amount of coal burnt annually in Great Britain as about 188,000,000 tons, of which about 14,100,000 tons is used in locomotives. The average efficiency of combustion of the coal used for all purposes throughout the country is only 25-30 per cent.; but in railway locomotives the efficiency of combustion is 70-80 per cent., so that the railways clearly are less wasteful of coal than most consumers. Mr. Bennett estimated that the railways did not contribute more than 2.5 per cent. to the total amount of atmospheric pollution in the country. The same conclusion was stated to be supported by the records of the Atmospheric Pollution Research Committee of the Department of Scientific and Industrial Research.

This seems to indicate a much better state of affairs than in the United States. Mr. Roy V. Wright, speaking in 1946, at the 39th Annual Meeting of the Smoke Prevention Association, Minneapolis, referred to Professor Goss's statement that in 1915, in Chicago, steam locomotives contributed not more than 22.06 per cent. of the total smoke of that city. Mr. Wright said that by 1939 this percentage had been reduced to 10.15; and this must be attributed to better design and operation of locomotives, for in 1939 there certainly were not enough diesel or electric locomotives in service in the U.S.A. to account for such a reduction.

(b) The Wastage of Unburnt Fuel

Having seen that the proportion of atmospheric pollution due to railways may lie between 2.5 per cent. and 10.15 per cent. of the total in different countries, the fact must be admitted that we have here a definite wastage of valuable fuel. It is not too much to suppose that the greater part of the unburned carbon thrown out of the chimney of a locomotive could be made to yield up its energy in the form of heat if a suitable proportion of oxygen in the form of secondary air could be introduced above the fuel bed. To attempt to do this by manipulation of the firedoor alone, though the normal course in Great Britain, is not entirely satisfactory, because fine adjustment is impossible, and even if it were practicable the whole arrangement would be thrown out of gear by the opening of the door at frequent intervals for firing.

A further source of unburnt fuel which is much more difficult to deal with will perhaps occur to practical enginemen but probably not to the laboratory investigator. When a shovelful of coal is fired, there will almost certainly be some fine particles mixed with the larger lumps. The lumps will fall on to the fuel bed, but the finer matter will be drawn off the shovel by the action of the blast and will pass straight into the firetubes. The only remedy seems to be to have a fierce enough heat in the upper part of the firebox, and a sufficiently large combustion chamber, for burning of these particles to be initiated before they enter the tubes.

The matter is difficult, for combustion is not an instantaneous process; time is in fact needed for (1) bringing the coal to ignition temperature; (2) vaporization of the moisture content; (3) distillation and subsequent burning of the volatiles; and (4) actual ignition of the carbon.

The most hopeful line of action for the future would seem to be the provision of large combustion chambers in firebox designs.

Incidentally, insufficient grate area has been a cause of smoke emission in certain locomotive designs. If the grate area is too small and the engine is being worked hard, the fireman will tend to throw in more coal in order to provide enough fuel for a high rate of evaporation. The fire will thus be of an undue thickness, and therefore the air supplied via the ashpan will have difficulty in getting through the fuel bed. This is not merely a question of enhanced resistance to air flow due to the increased thickness, but a result of all the entering air being used up in combustion before it can get through the fire.

In Bulletin No. 135 of the U.S. Bureau of Mines ("Combustion of Coal and Design of Furnaces"), Kreisinger cites an example of a very high firing rate of 185 lb. per sq. ft. per hour; with a fuel bed 6 in. to 12 in. thick, the whole of the air supplied below the firebars was used up at a level 4 in. above the grate. In this case the ratio of the weight of air supplied to the weight of fuel gasified remained substantially constant at about 7/1, i.e. less than half the amount of air theoretically needed for complete combustion (about 15 lb. air per 1 lb. of fuel) is likely to get through the fuel bed.

When conditions like this obtain, it is folly to go on piling coal into the firebox, which will simply generate more smoke in the tubes instead of more steam in the steam space. If it is not possible to modify the design so that a more ample grate area, with a correspondingly low rate of firing per unit area can be adopted, arrangements should be made so that the extra air needed for any exceptionally high rate (say over 100 lb. coal per sq. ft. grate per hour) can be supplied as secondary air to be introduced above the fuel bed. Thus we are led back to D. K. Clark and his steam-air jets of the 1850s, the basic idea of the "overfire air jets" which are being widely hailed as a smoke-reducing device in America to-day.

Work carried out at the Battelle Memorial Institute, Columbus, Ohio, seems to show that "front end" design (i.e. disposition of cylinder exhaust passages, blast pipe, and layout of smokebox) does not increase the supply of air quite proportionally to the output of the locomotive; an increase certainly does take place but not enough to match the higher firing rates accompanying heavy steam demand. This is an important point to bear in mind; it is simply scientific confirmation of the well-known fact that engines which are being "thrashed" (worked very hard) are more wasteful in coal than those working comfortably within their capacity. Within reasonable limits, the whole beauty of the Stephensonian principle applies: an increased use of steam produces a stronger blast, which in turn promotes fiercer combustion, thus leading to a higher rate of evaporation and enabling the increased demand for steam to be met. If we abuse the machine by overloading it, we have to pay the penalty in various ways, one of which is the production of black smoke.

4. Past Efforts to Prevent Smoke Formation

(*a*) *Devices in connection with lighting-up*

In Great Britain, the time-honoured method of lighting up was to sprinkle a layer of coal over the firebars, and then to add two or three shovelfuls of live coals from the furnace used for drying the sand, which was an essential feature of every running shed. Further coal was then added, and the fire was built up gradually until steam began to be raised. The amount of coal used varied within wide limits; apart from

variation in grate areas between locomotives, an important influence was whether the engine was cold when lit up or still warm from a previous trip. From a cold start, as much as 7 cwt. of coal may be needed; where, however, it is possible to fill up the boiler with hot water, this figure may be reduced to 2 or 3 cwt.

Where the old-fashioned sand-drying furnace has been superseded by the Kelbus type, it is no longer possible to make raids on the latter for such purposes as lighting-up. In such cases, firelighters are used. Firelighters for locomotives vary considerably in materials from the creosote-impregnated sawdust type, about as big as a bundle of domestic firewood, which the author has noted in use at Camden shed, London Midland Region, to the wooden cage-like construction (a hollow 6 in. cube) which he has seen at Exeter, Western Region. The number of firelighters used will vary with grate area; he noticed in talking to the staff, a natural anxiety to dwell on miracles of steam raising in which only two to four firelighters were said to have been used, and a similar reluctance to admit that so many as fifteen or twenty were ever necessary.

To help to raise steam in a locomotive newly lighted up, a number of devices have been used; some of these are regarded as regular aids, others are looked upon as emergency devices.

During the author's two years at New England, Peterborough, the regular method was to couple up a copper pipe to the shed pilot which was in steam; the free end of this pipe was bent round to form a ring, and this was put down the chimney of the newly lighted engine. A number of holes in the ring emitted steam when a valve was opened, so that the effect of a blower was produced, which helped to get rid of black smoke and also hastened the steam-raising process. The author understands that a similar arrangement, but operated by compressed air, is used at certain Eastern Region sheds where compressed air lines are available. It would also be quite easy to use such a device where there are engines fitted with the Westinghouse compressed-air brake.

Of "emergency" methods, the author was very interested to learn of that practised at certain Southern Region sheds, as it virtually amounted to direct steaming, to be dealt with in detail later. An engine A in steam is hooked on to an engine B freshly lighted up; the steam-heating hoses (for carriage warming) on the two engines are then coupled up and the carriage heating valve is opened in the cabs of both engines. Steam then flows from engine A into engine B and, with the improved strength of present-day steam-heating hose, a pressure up to 60 lb. per sq. in. can be attained. When the gauge in the cab of engine B shows that pressure is beginning to rise, the blower can be opened and can so help to draw up the fire on this engine. The same idea is practised at certain Western Region sheds; but it is looked upon with some misgiving, there being a general belief that such an emergency method of forcing steam generation must be harmful, and this is probably supported by remembrance of certain old-time statutory regulations regarding the number of hours which must be allowed for raising full working pressure in boilers.

In the U.S.A., the most striking device for aiding steam raising is an electric fan made to fit inside the chimney and so draw the fire up from the firebox and through the tubes. It would seem to be well worthy of extended trial in this country. The New York Central also uses gas to some extent, introduced below the firebars, and giving the effect of a domestic "gas poker" on a large scale. Another successful device is a portable burner, working on the "Primus" principle and fed with oil from a tank on wheels, pressure being supplied by compressed air. Where none of these devices is available, wood is used to start the fire and is ignited with oily waste.

The different conditions in the U.S.A. and the increasing awareness, of late, of the value of overfire air, have led to the use of a smoke-consuming device in lighting-up. Compressed air is led to a metal pipe having a T-shaped end in which several small holes are drilled. This is merely a means for introducing a quantity of air where it is wanted and enabling it to spread through the space above the fuel bed so as to promote combustion and lead the gases towards the tubeplate.

(*b*) *Overfire Air Jets during Running*

The chief exponent of overfire air jets in this country, as already mentioned, was D. K. Clark, who saw that engines needed such a device to enable them to consume coal before the introduction of the brick arch in combination with the deflector plate. His fireboxes had 16 such jets, 8 at the front and 8 at the back, placed about 1 ft. above the firebars. These jets discharged into holes 2 in. in diameter, formed by threaded pipes screwed into both inner and outer fireboxes; in the 1880s the holes were enlarged to 3 in. diameter, and the use of the device was very deeply rooted on the small railway concerned.

During the years 1908-12 engine No. 189 of the London, Brighton and South Coast Railway was fitted with a device for heating combustion air, with the aim of increasing the efficiency and reducing smoke, but the extra cost and complication apparently were not considered to be justified.

In 1913, however, tests carried out by the Pennsylvania Railroad at Altoona showed that steam-air jets discharging into the firebox above the fuel bed had "a decided value in reducing smoke under the varied conditions of the tests." In addition to reducing the smoke by some 70 per cent. they increased the rate of evaporation of the boiler and made it possible to use coal of rather lower quality. They were, however, so noisy that when their extended application on railways was begun the engine crews would not use them. The tubes were found to be too short; in addition to the noise, steam consumption was excessive. Induction tubes about 14 in. long are now in use; and silencers have been designed, to reduce the noise. Experiments to find the best location of these jets have been most valuable; a spacing of 16 in. between centres is now said to be suitable. Jets are not placed opposite one another along the two longer sides of the firebox, but are staggered to give, in effect, 8 in. centres as between opposite sides.

While much work on these jets has been done in the U.S.A., where about 2,000 locomotives incorporating them are now in service, contributions to the solution of the smoke problem have also been made in Great Britain. In 1933 a smoke eliminator was fitted to tank locomotive No. 1544 on the L.M. & S.R. and consisted of a method of injecting air by four steam jets into the firebox above the brick arch. In 1949 another device; the "Jay-Gee" smoke eliminator was described in the technical press, it has been fitted to a "J 50" class locomotive and certain other engines of the former L.N.E.R. and is claimed to be so effective in preventing smoke that in one engine with the device the smokebox did not need to be cleaned nor did the tubes need to be swept, for 5 weeks.

Recently the South Australian Railways have been highly successful in the provision of very high-pressure air jets above the firedoor. These have the effect of deflecting cinders beneath the brick arch; these cinders would otherwise be drawn through the tubes.

At the present time tests are proceeding with simple induction jets supplied with air from a blower driven by a steam turbine. If the turbine exhaust could be made to preheat the air, it would seem that a great saving in costs could be achieved. This layout offers a wide range of capacity and penetration.

The use of exhaust steam from the locomotive has been proposed for overfire air jets, but a major difficulty would seem to be that, owing to the low

kinetic energy of the exhaust steam, very large amounts would be needed.

(*c*) *Smoke Troughs, etc., in Stations and Running Sheds*

The emission of smoke by locomotives, though largely avoidable in stations, and probably not entirely avoidable in running sheds, should be allowed for in both these classes of buildings by the provision of smoke troughs whenever possible. If at all feasible, these troughs should be continuous, so as to obviate the need for standing the locomotive at a given point for the trough to be effective. The author was very surprised to see that this was not done in the smoke troughs installed in the new London Midland Region shed at Chester and feels that the Railway Executive sooner or later will regret not having done so.

The deleterious effects of smoke and sulphur fumes are only too well known in running sheds; metals have a short life in this atmosphere, and experiments have therefore been made with asbestos cloth for smoke ducts. In the early trials, the stitching of the white asbestos failed, though blue asbestos withstood the test conditions well.

Whether smoke troughs in running sheds could be linked up with apparatus for smoke removal by filtration or some other means remains to be seen, but a method of washing these gases might well be considered in the light of experience gained at Battersea, Fulham, and other power stations. At the Science Museum Conference of the National Smoke Abatement Society in 1936, the washing of flue gases was considered, and some wet filtration process was held to be necessary; the apparatus could be much simplified if the oxides of sulphur were not removed. Where wet washing was impossible, electrostatic precipitation might be tried. It would be surely worth while for the Railway Executive to consider whether any of these proposals could be applied, and to reflect on the possibility of leading all the smoke troughs in a running shed into one or two tall chimneys, as is being tried in certain American sheds, so as to facilitate the incorporation of filtration plant.

5. Present Needs, and Directions which might be followed

(*a*) *Direct Steaming*

The author feels most strongly that the widespread adoption of direct steaming in British running sheds would reduce very considerably the emission of thick smoke during lighting-up, which is the worst feature of operaton with steam locomotives. By direct steaming is meant the conveying of live steam under pressure into a locomotive which is freshly lit up, so as to warm the boiler and indeed to help with the initiation of pressure within it. The Western and Southern Regions have, as already mentioned, been working instinctively towards that end, using the steam-heating hose as the live steam connection.

What is really needed, however, is a live steam line in every running shed, which should run between the shed roads and have a connection every 30 or 40 feet or so, thus obviating the need for immobilizing a locomotive already in steam. There is no need to spend a vast amount of capital on such a scheme. A boiler from a scrapped locomotive would do very well, and apart from the piping and couplings, little more than a few steam traps would be needed to get rid of condensate in the pipe lines. Railway men should get over their shyness about direct steaming and regard it as a legitimate method instead of something to be done rather furtively like an "under the counter" deal.

(*b*) *Improved methods of lighting-up*

The old method of transferring shovelfuls of coal from a furnace is dying out. It was not, however, quite so inefficient as might be supposed, but was undoubtedly expensive, particularly in labour. Firelighters are being used increasingly, but there would appear to be need for more thorough instruction in their use, and a clear idea of how much coal should be placed in the firebox when lighting-up. The time taken

to raise steam with firelighters is about 2½-3 hours, no additional aids to steaming other than the blower of the engine being used. Observations at Doncaster in 1945 showed that 12 firelighters and 10 cwts. of coal were used for a 2-6-2 tender locomotive; 8 firelighters and 7-8 cwts. of coal for a 4-4-2 tender locomotive; and 6 firelighters and 2½ cwts. of coal for a 0-6-0 shunting tank locomotive.

The use of smokeless fuel might well be considered when lighting up, to be followed by coal when the firebox is really hot. At the Botanic Gardens locomotive shed, Hull, a method was introduced many years ago (as a result of the efforts of a very vigorous and determined smoke officer in the city) of using coke initially for this purpose. The author visited this shed in June, 1950, to learn what he could of the technique, and was told that the coke was used in conjunction with firelighters and that it was the practice to empty one tub of coke into the tender when the engine was at the coal stage, so as to have it ready to be shovelled on to the fire when lighting up afterwards. The author has wondered if fuel such as "Coalite" could be used for this purpose.

The Americans have taken to portable oil burners on the Primus principle, as already stated, for insertion in the firebox so as to ignite coal previously placed there. The method might well be given a trial in this country; alternatively something like the domestic "gas poker" on a large scale might be developed. Such devices have the merit of heating all the air and gases in the firebox, which is a much more promising way of battling with the smoke problem than leaving it to the heat from a small patch of ignited coal surrounded by other coal that is not even warm.

(*c*) *Hot Water in Running Sheds*

All running sheds of any size (say over 40 engines) should have a hot-water washing-out system, which should also be combined with a really effective method of treating the feed water. What is needed is some form of the present hot-water boiler-washing system used in sheds of the former Great Northern Railway. The hot water in the boiler of an engine which has finished a run and is due for boiler washing should not be run to waste but blown into a reservoir, after which it should be treated with the appropriate chemicals to produce zero hardness and then stored at a high temperature, ready for filling up the boiler of another locomotive. The actual washing-out process should also be performed with hot water whenever possible. By such means it should be possible to keep a boiler hot for weeks on end; indeed it should not be allowed to cool unless the engine is to be stopped for some days for repairs.

The feed water treatment introduced on the French Railways by M. Armand, known as the "T.I.A." (Traitement Intégral Armand), which is also being tried on the Southern Region, might be usefully considered here. With water of zero hardness at every water column, washing-out should be needed much less frequently; and with hot-water washing-out at the sheds, the lighting up of a cold engine should also be a comparatively rare occurrence. With the addition of a smoke eliminator fulfilling the claims made by, say, the "Jay-Gee" device already mentioned, boiler tubes should remain cleaner, and combustion should be more efficient during difficult periods when there is a comparatively large amount of unburnt coal in the firebox. The provision of a drop-grate enables the fire to be cleaned more conveniently; and thus we begin to see the directions in which future developments might go.

(*d*) *Alternative Fuels*; *Alternative Forms of Motive Power*

Because of his interest in the locomotive designs of the former Great Eastern Railway, the author has always felt that liquid fuel is the most desirable kind—theoretically at any rate—for the steam locomotive. It is more easily handled than coal and its use involves much less arduous physical

abour — an important consideration when (as now) it is difficult to attract young men of the right type into the railway service. The Holden apparatus stood the test of many years' successful working on the Great Eastern, and would seem to be a good basis for any future developments.

Future developments in the use of iquid fuel should, however, be the result of a sincere desire on the part of he Railway Executive to follow the matter up, and should not be forced on the railways against their better udgment, as was the case with the abortive Government - sponsored scheme for equipping over 1,200 locomotives for oil fuel some four years ago. The best that can be said for this ll-fated idea was that it brought with t some useful developments in oil-burner design, notably that of Messrs. Laidlaw, Drew and Company.

Not being a fuel chemist, the author would like information on whether it would be possible to effect a certain degree of carbonization of coal in gas works, so that in addition to the gaseous yield, the process could be so controlled as to produce tar or benzole by-products which could be burnt successfully in the fireboxes of steam ocomotives.

Ever since he can remember anything, the author has listened to the story of how the days of the steam locomotive are numbered; first it was electricity; then we had experimental turbine locomotives; then the Kitson-Still locomotive in which an unhappy marriage was effected between steam and internal combustion engines; then he Diesel-electric machine made its appearance; and now the gas turbine has been given a trial in Great Britain.

The bulk of the railway transport in his country, however, continues to be handled by steam locomotives, and his will be the case, in all probability for many years to come, provided that due attention is given to the economics of the problem, for there is not the slightest doubt that the steam locomotive is the cheapest form of motive power that we have. That being so, the author feels that efforts to reduce smoke will be well worth while, for although the use of Diesel locomotives may be extended, and although additional urban railway systems may be electrified, it will hardly be possible to find the money for complete conversion to one or other of these costly alternatives. Moreover, since coal is our natural indigenous fuel, future developments in the direction of a new prime mover should surely be towards a pulverized-fuel gas turbine, rather than towards the misguided adoption of a machine depending on imported fuel.

6. Staff Training and Discipline

Neasden running shed has long been a black spot in the locomotive world around London. But it is only a type, or a symptom: the basic faults apply to nearly all sheds, especially the older ones. Dirty, battered, and ill-equipped, with leaky roofs and depressing mess-rooms, they give the impression of a forlorn wreck from a world that is past and gone. Small wonder that the engines emerging from them look dirty and unkempt. Who in his right senses is going to work at Neasden when, with the North Circular Road close at hand, he can easily reach new, cheerful, and attractive factories and workshops, with cleaner work and better pay? Yet there are a very few, who will put up with the drawbacks of railway service because of the interest of the work which continues to be a link between railwaymen all over the world.

There have been signs of some improvement recently, and it is much to be hoped that it will continue. But the author always feels particularly indignant when new quarters with excellent lighting and lavish equipment, are provided for, say, Diesel locomotives, which are segregated from contamination by the steam locomotive fleet, while the latter which are just as much revenue earners, together with the staff concerned, are left to pig it in the same old neglected premises as before. He considers that this is a psychological mistake of a very high order. If half the attention accorded to

the Diesel locomotive were given to the steam locomotive, the latter would be achieving the same records as the former.*

So much for the environment of the shed staff. Now for the engine crews. We have nowadays a difficult set of circumstances for the Railway Executive to overcome: a large proportion of firemen lacking in experience, though not in intelligence, yet not in all cases amenable to discipline.

By the word "discipline" is meant willingness to learn, whether from the driver or from regular instruction courses or from mutual improvement classes. The greatest restraint has to be exercised, too, for to-day the strength of the trade unions is such that little more than a word out of season is enough to precipitate a paralysing strike. The author feels that mutual improvement classes can and should shoulder the main burden in instructing the fireman, at least so far as instruction can be imparted in a classroom. For the practical experience on the road, much can be done by the running shed superintendents in seeing that, as far as possible, a driver and his fireman are reasonably well suited to each other. There is nothing more baffling and discouraging for the young fireman than a driver who, not content with being completely unhelpful, by withholding all his experience and advice, creates a hostile and miserable atmosphere by his own sour temperament—a type of pollution which the author feels to be worse than any smoke nuisance.

Let us then suppose we can get some good drivers and firemen together. What of the others? That there is some irresponsible behaviour on the part of some of the others cannot be denied. A locomotive at Camden depot obviously with some steam up was seen by the author to be pouring out thick black smoke; the driver was asked by the shed foreman to put on the blower but refused flatly to do so, adopting a most truculent attitude at the same time, and complaining that one couldn't do anything with a boiler pressure of only 50 lb. per sq. in., which of course was nonsense. As a visitor, the author withdrew; the foreman climbed into the cab and himself put the blower on. The smoke cleared in a few seconds but this small incident shows the attitude which has to be overcome; magnified several hundred times, to represent its effect throughout the country, it illustrates how much of the smoke nuisance is caused by obstinate and wilful mismanagement—apart from that due to ignorance alone.

The author applauds the action of the former L.M. & S.R. in appointing a Smoke Abatement Officer (Mr. L. G. Johnson). This officer is stationed in London, and though normally remaining on his own line he has had considerable additions to his responsibilities since the nationalization of the railways, and is in fact in charge of the whole London area for British Railways. A great deal of Mr. Johnson's time is taken up by liaison duties with London County Council smoke inspectors, so during his absence from his headquarters the outside foreman deputises for him. The author feels sure that Mr. Johnson has been given far too much to do; it would seem impracticable to have one man looking after so vast an area, and it would probably be better if smoke abatement officers were appointed for each Region. The original idea, however, is basically sound enough; the smoke abatement officer should be a frequent speaker at mutual improvement classes and should have a hand in the planning of all instruction courses such as the fourteen days "schooling" under a firing instructor which are taken by new hands.

A combination of common sense and hard work would go a very long way towards defeating the black smoke bogey. Common sense here is taken to include freedom from prejudice. Because a Great Central design of firebox gives good results with a very thick fire at the back of the firebox, that is no argument for filling up the firebox

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* See *Railway Mechanical Engineer*, 1947, vol. 121, p. 545.

of one of the former Great Eastern locomotives up to the firedoor, and then blaming the engine for the poor results that follow; it is simply the consequence of mishandling a locomotive designed for a fire about 4 in. or 5 in. thick, spread fairly evenly over the bars.

7. Co-operation with Local Authorities

Finally, the author hopes that in future there will be increased co-operation on the part of motive power staff with the local smoke prevention officers in the various boroughs. An enterprising and determined municipal smoke officer can work wonders in bad cases, as witness the example of Botanic Gardens shed, Hull. In the U.S.A., extremely stringent regulations regarding smoke prevention are in force in many states and cities, and have been very largely successful in forcing the railways to give attention to their smoke problems. In this country, of course, the railways are subject to the Acts and Orders concerning smoke abatement, but the successful administration of these regulations can only be achieved by goodwill and understanding on both sides.

(II) THE ATTACK ON THE PROBLEM

M. G. Bennett, M.Sc., M.Inst.F.

(British Railways)

A Superintendent of Motive Power on a British Railway noticed an engine standing and making undue smoke. He climbed into the cab, took the shovel from the fireman, removed half-a-dozen shovelfuls of coal from the tender and threw them over the side. The fireman looked on astonished. The superintendent then explained to the fireman that, by only partly burning the coal and sending the residue out by the chimney, he was just as truly wasting coal as if he threw it away and he was, moreover, creating a nuisance.

This episode epitomises the story of Railway Smoke. Let us examine it in more detail.

That steam engines, like all coal burning appliances, do make smoke cannot be denied. Indeed, it would be impossible to carry on the service of transport without making some smoke. This fact is recognised in the law which imposes no penalty if the smoke which is produced is not more than that which is necessary for the carrying on of the business of the railway. But the law requires and the railways desire that smoke shall not be more than that.

Smoke is a very costly nuisance. The railways are very unwilling victims of it. It has been shown in a previous paper* that the railways contribute only something like 2½ per cent. to the total atmospheric pollution of the country, but they are exposed to the pollution created by all the rest of the community. The railways to the south and west of London are clean mainly because they are on the clean side of London. The stations and trains of even electric railways on the smoky side of London, or any other great city, take as much cleaning as steam railways. Further, the railways no doubt suffer more from the smoke they themselves produce than do their neighbours, for, not only do they have to pay for the coal from which it is produced, but most of it falls on their own property. The fuel bill of the railways runs to some £700,000 per week, and a very small percentage loss on such a figure constitutes a big sum of money. There has also to be counted the cost of keeping the premises and rolling stock clean, and of combating corrosion. The life

* Joint Conference of the Institute of Fuel and National Smoke Abatement Society, February 23rd, 1945.

of rails in tunnels may be as little as one-tenth the life in a good site in the open. Last, but not least, smoke hampers the efforts of the railways to provide the best possible working conditions for the men to work in.

No wonder, then, that the superintendent took notice of the engine. Observe that the engine was standing. Little smoke is made when running, for then the conditions for maximum combustion are at their best and compare well with even good stationary boiler conditions. The coal to water efficiencies of steam locomotives are of the order of 70 to 80 per cent. This has been achieved by a close study of the design of boiler and grate, and of methods of firing.

There is no need here to examine in detail the conditions conducive to high boiler efficiency. The rate of consumption of coal per square foot of grate area should obviously be as low as the demand for steam and the dimensional limitations permit and grate areas are in fact continually being increased. Much attention has been paid to the design of dampers and fire hole doors to ensure adequate primary and secondary air ; and of brick arches to ensure adequate turbulence and combustion over the fuel bed. The front ends of boilers have also had much study. A fairly recent innovation is the fitting of a screen, which tends to equalise the blast suction over the face of the front plate and thus reduce the amount of unburnt fuel lifted off the fire bed.

The Art of Firing

The art of firing has also been subjected to much study. The validity of the time-honoured injunction "little and often" has been confirmed and quantified by detailed studies of the steam demands during typical operational runs and of coal consumptions, with different firing cycles.

A low calorific value of the coal must reduce the B.Th.U. output of the boiler, but should not result in smoke. Indeed, if it is fired in such a way as to produce smoke, the position is aggravated, for a part of what little heat there is in the coal is being wasted. A coal of high volatile content is more difficult to burn smokelessly in the limited confines of a locomotive fire-box than one of low volatility. Nevertheless, with the improvements in design mentioned above and with skilful management, it should be possible to fire an engine when running without making more than a barely perceptible amount of smoke.

When standing, however, the conditions are not always so good. The draught of a standing engine in steam is limited to that which can be provided by the blower. This is adequate to build up a fire as fast as is normally required and indeed as fast as is desirable when "steam raising" in order not to impose strains due to rapid temperature changes. When starting from cold, however, it takes some five hours to generate sufficient pressure to use the blower and during this period the air supply to the grate is only sufficient to support a very limited amount of combustion. To avoid temperature strains, it is not desirable to accelerate this phase of steam raising, but it will be obvious that, unless great care is exercised, it is easy to overdo the stoking and to put on more coal than the air supply can cope with.

The pre-steaming of locomotives is one way of preventing smoke during the first stage of steam raising. The loco boiler is fed with steam from a stationary boiler, until a sufficient pressure is available to use the blower. A fire may then be lighted in the locomotive in the ordinary way and given sufficient draught to burn smokelessly, if it is built up slowly. The system involves capital expenditure on new plant. Nevertheless, schemes are being prepared, and locomotives are being fitted with cocks to permit pre-steaming should it be adopted as general policy.

Such smoke as is produced by engines occurs therefore mostly at engine sheds and, perhaps to a lesser extent, at places where the demand for steam fluctuates widely, such as marshalling yards and inclines where banking engines operate.

A great deal of attention has been paid to this problem. The obvious thing to try is a smokeless fuel, but even a smokeless fuel will smoke if it is not given enough air. Coke, gas and steam coal have all been tried. There are a number of places up and down the line where coke or steam coal is used, at some cost and inconvenience to the railway, to mitigate smoke. They do give some improvement but they have other disadvantages, and the result is little better than with the traditional method, provided the job is done properly.

It will not have escaped notice that skill is needed to do the job properly, without smoke, whether running, standing or steam raising. The anecdote in the opening paragraph illustrates the policy of the railways in this respect. It is to help firemen to achieve their natural desire to do their job well.

Training

Every recruit into the Locomotive Running Departments of the British Railways goes through a systematic course of training and examination, with constant opportunities for refresher courses, as he advances up the promotional ladder. His training is not just a haphazard matter of picking up skill by working with more experienced men. He does naturally learn a lot in this way, for firing an engine is still as much an art as a science, affected in practice not only by circumstances that can be anticipated but by numerous imponderable factors such as quality of coal and unscheduled stops, which may vary considerably. Practical experience is therefore essential. But experience is backed by instruction.

At Mutual Improvement Classes, firing practice has long been an important subject for lecture and discussion. Here the recruit learns from instructors how an engine works, the theory of combustion and the practice of firing. He asks questions and discusses his difficulties with his older colleagues and he is provided with illustrated literature on the subject. He continues to attend these classes as he is promoted, so that the process of learning and of passing on the skill he has learnt to his younger colleagues is a continuous one. The team of inspectors engaged on firing instruction has of recent years been considerably augmented. They now number about a hundred. Their duties include lecturing to classes, practical instruction on the footplate, the investigation of complaints about smoke or inefficient firing, the study of the best firing schedules for different runs and so on. Friendly advice, an instance of which is quoted in the opening paragraph, is cumulatively having a marked effect on the efficiency with which locomotive coal is being used.

The effort of the inspectors is powerfully assisted by three instructional trains which tour the country, complete with cinema, demonstration car and quarters for the instructor-in-charge. These trains, of two coaches each, are stabled at a depot for about three days to allow all the men stationed locally the opportunity of going through them. Some 1,500 do so each year. In the cinema, films are shown describing the theory and practice of firing, the duties and responsibilities of a fireman, combustion and other suitable subjects. In the demonstration coach, sectionalized parts of a locomotive are laid out so that they can be handled by the men and their method of working, therefore, clearly understood. There is a boiler back plate complete with all controls and dials, which is fed with steam, so that it works. It is hoped that all members will find time to visit one of these trains during the Conference and see for themselves the sort of assistance which is now being given to the firemen to help them to use coal efficiently and therefore smokelessly.

A useful means for demonstrating the difference between good and bad firing, and for establishing a reasonable figure for the coal consumption for a particular run, has been found in the coal-weighing tender. With this it is possible to weigh with an accuracy of a few pounds the amount of coal on the

tender whenever the engine stops and hence, by applying a correction for the amount of coal on the grate, to calculate the amount consumed during the intervals of running. Apart from the value of this device in testing different coals and other similar purposes, it provides most convincing proof to firemen of the saving of coal and of their own labour, when good firing is practised. Differences of 10 per cent. are not uncommon, on the same run and with the same coal, between consumptions with haphazard and with controlled firing.

These different educational methods are of particular value now that military service and other causes are resulting in the need for quicker promotion than was the case before the war, to maintain the team of drivers and firemen at full strength. It is pleasant to record that full use is being made of them.

It is well-nigh impossible to prove statistically that the sum total of all the efforts being made to reduce smoke have in effect been successful, but those people who have been watching developments and making qualitative assessments over a long period will, it is thought, concur that there has been a continual improvement, bearing in mind the difficulties imposed by the variable quality of coal and relative lack of footplate experience compared with the old days.

The Future

So much for the present picture. What of the future?

There is presumably no need to emphasize the fact that capital expenditure is severely limited. Many people are hampered in their development work thereby, even to the detriment of net revenue. The economic policy of full employment—no doubt justified in itself—also means that schemes involving additional man-hours can only be indulged in to a very limited extent. Supposing therefore that pre-steaming were found to be both economically and technically sound, as a means of preventing smoke during steam raising, it would take many years before there could be an extensive application of the system. For similar reasons, a number of schemes for modernizing boiler and furnace plant in the manufacturing works of the railways have had to be deferred—reluctantly—till the capital is available.

Public interest is probably most concerned with the future as it affects the form of motive power. They know of the trials of different forms of traction, such as diesels and oil and pulverized coal turbines, and they wonder whether one of these or electricity is the answer for the future. The question is hardly relevant, at the moment, for the time and capital involved in any major change are so stupendous that no radical alteration can be expected for many years. The conventional steam engine is certainly with us for a long time and the main improvements in smoke suppression, in the foreseeable future, lie in the more efficient operation of these engines.

While alternative forms of traction, when they are realizable, may have economic, operational or other advantages, it is not to be supposed that they necessarily result in less atmospheric pollution. This is no doubt true of electricity generated at central stations, although these stations have their own pollution problems. If and when atomic power is used for central generation there will be the even bigger problem of pollution by radioactive material, the possible deleterious effect of which may well be more dire than smoke and sulphurous fumes. Even oil burning engines, either diesel or turbine, emit corrosive fumes and the pulverized coal turbine will have similar problems of combustion and unburnt fuel disposal as the conventional steam engine.

The Chairman and the Chief Officer of Motive Power of the Railway Executive have hinted that the general trend may well be in the direction of centrally generated electricity: but changes in capital cost and of coal cost since the Weir report will necessitate a complete

reassessment of the economics of electrification as computed in that report. Further, the economics of motive power, as of the whole system of transport, depend fundamentally on the traffic demands on the different services of the British Transport Commission, which in turn depend on the level of productivity of the country. The advantages of electrification for intensive suburban traffic are well recognized; indeed, as is well known, schemes of electrification on a limited scale have been proceeded with since the war. Similarly the advantages of small diesel engines for shunting are recognized and changes in this direction are progressing. Diesel units are in use for branch line and cross country work. All these developments should result in less smoke. How much further they can and should be taken, and how rapidly, must await the examination of the trials in progress, the elucidation of the position both as regards traffic demand, and the release of capital.

Sir Eustace Missenden remarked to the Institute of Transport: "Smoke, steam, dirt and smells were once the symbols of power." They are no longer so. They are recognized as symbols of waste, detracting from the amenity of travel and spoiling the environment in which railway men work. They are yielding to attack, by both technical and educational means; but the battle is not yet won.

DISCUSSION ON RAILWAY SMOKE

M. G. Bennett, in introducing his paper said: I wish to thank the Society for the invitation to address this Conference, which is the third I have had the pleasure of attending. The interest of the Railways in smoke abatement is shown by this message from my Chairman, Sir Eustace Missenden, which I have been asked to give to you:

"Anything that can be done by coal users—whether industrial or domestic—to reduce smoke, is a valuable contribution to the nation, both from the point of view of the avoidance of waste and as an aid to cleanliness and health.

"Problems that have been with us for so long often tend to be ignored or dismissed as insoluble; but this is a counsel of despair, and therefore I greatly welcome the work of your Society and of its conferences in keeping the matter so constantly before us all."

Secondly, I would like to thank Mr. Skeat for the impartiality of his opening remarks. He suggests that the railway smoke problem is both bigger and smaller than might have been thought; that the Railways ought not to make any smoke, or alternatively should spend money on disposing of it; he "supposes we can get some good drivers and firemen together" and also suggests that drivers are unwilling to teach and the firemen to learn. I am very happy to take the opportunity he gives me to tell you which side of the picture is the right one, and what the policy of the Railway Executive is.

It must be admitted that the Railways do make some smoke; it would be impossible to carry on the service of transport by steam engines—and steam engines are with us for many years—without some smoke. Unfortunately for ourselves, where we make smoke it is very obvious, and we are the greatest sufferers from it. The policy of the Executive is to do its utmost to cut down the amount of smoke rather than to spend money on extraction and ventilation schemes to dispose of it. Improved design of engines, the study of methods of steam raising and firing, and the educational system for drivers and firemen are having a marked effect. These and other steps are described more fully in the paper before you.

I wish to take up very definitely Mr. Skeat's point in regard to the cooperation of the men. I believe that everybody likes to do his job as well as he can. Railwaymen are no exception. In every large family there are a few black sheep, but there is no doubt that

the Unions and the men as a whole are keen and loyal. Certainly, the older men do give a very great deal of willing help in the training of the new entrants.

The use made of the educational systems which are available shows how much they are appreciated. I wish to amend the figure of attendances shown in my paper; the total attendances in the three trains is something like 50,000 a year. Fuel Efficiency is only one of the subjects dealt with but the number concerned with this subject must amount to much more than the figure in the paper.

In no other fuel using industry has so much power to be generated in so small a space under such varying conditions of load and fuel quality. In view of this the standard of fuel efficiency is extraordinarily high, and is matched by the efforts being made to improve upon it still further.

W. O. Skeat, in a brief presentation of his paper, gave an outline of the history of the conventional locomotive firebox. He said that for about 30 years (roughly 1830-60) locomotive engineers had used coke, but had continually tried to find some way in which raw coal could be burnt without the creation of a nuisance by smoke emission. Finally, they had hit on the right solution by the provision of a brick arch, abutting on to the firebox tubeplate, and a deflector plate placed inside the firedoor, and just above it. Thus the firebox was divided into two parts: the lower, including the firebars and the fuel on them, was the furnace; and the upper was the combustion chamber. Given a fairly well-skilled fireman, and the right sort of fuel, a locomotive with a firebox of this kind could consume coal without making any undue amount of smoke. Generally, a fairly thin white-hot fire gave the best results; it required firing "little and often," *i.e.*, small quantities of coal at frequent intervals. Skilled attention was needed, and the method would fail in the hands of an undisciplined fireman, or if bad coal were supplied.

The emission of black smoke was far less of a nuisance in the case of trains on the move than when engines were standing in stations or shunting, or working in tunnels. But the "hard core" of the problem was the production of black smoke in running sheds, which was often bad in cases where locomotives had just been lit up, and particularly objectionable if engines had been lit up "from cold," e.g., after being laid off for repairs. The remedy was to keep engines in steam, or at least to prevent them from cooling, for as long a period as possible. This could only be done by modifying the time-honoured methods of boiler washing. The French "T.I.A." process of feed water treatment, designed to minimize the formation of boiler scale and to enable the periods between boiler washings to be increased very greatly might be worthy of adoption. Intervals between tube-sweeping operations could be much extended by adopting some form of smoke eliminator. Proprietary makes of this device were already available.

Lighting-up methods were considered in detail in the paper. Lighting-up with live coals had been widely superseded by firelighters. An American device worth noting comprised a sort of extraction fan, lowered into the chimney of the engine just lit up, so as to draw up the fire. Another American method consisted of igniting coals placed ready in the firebox by directing on to them a large oil-burning torch working on the "primus" principle. It had also been suggested that a device on the lines of the domestic "gas poker" might be tried.

Far above these inventions in its high promise, however, was the principle of "direct steaming," in which steam was taken from a pipe line in the running shed and led directly into the boiler of an engine to be put in steam, so as to warm it before the fire was lit. This apparatus merited serious consideration by the Railway Executive, for installation wherever possible.

Finally, increased efforts would be needed to produce competent firemen and to inculcate "pride in the job," particularly through the help of instruction classes; whilst at the administrative level, greater co-operation between

railway smoke officers and local authorities would be fruitful in the devising of new ways to lessen the nuisance caused by railway smoke.

G. H. Wilkinson (Chief Sanitary Inspector, Corby U.D.C.) drew attention to the persistent heavy smoke nuisance from coal-fired locomotives used in heavy industry. Two contributing factors were that the fireman was often away from the footplate performing ancillary duties ; and an apparent unwritten law that fires must not be stoked (and so cause annoyance to fellow employees) in or around plant buildings. Consequently the rule of firing little and often could not be applied.

It was probably true to say that the great majority of these locomotives were many years old. Provision will have been made for depreciation and replacement. Therefore adequate funds should be available for new locomotives. The alternative fuels were : (1) electricity—but there are obvious dangers, e.g., the live rail ; (2) gas turbine—but this is only in the experimental stage ; (3) oil or pulverized fuels. Mr. Wilkinson suggested that industry should be urged to undertake a gradual change-over to oil-fired locomotives.

P. H. Saunders (Liverpool) said he had followed the Papers with particular interest as he had been a co-apprentice locomotive engineer with Mr. Skeat, one of the Authors, and there was no doubt about the efforts the Railways were making or had made in the past to improve the standard of training of locomotive firemen. He recalled experiments many years ago in making photographic records of the movements of a fireman during firing on the footplate in order to obtain a picture of the most efficient way to do the work for the benefit of trainees.

He also referred to co-operation in Liverpool by the Railways Executive which had resulted greatly in reducing the smoke nuisance, in one case a conversion of raw coal burning plant, hand fired, to oil burning at a cost of over £7,000 and in another case by a special film show in the Instructional Train Unit for fuel economy and smoke abatement students.

Mr. Saunders asked to what extent mechanical stoking could be applied to long distance engines using low grade fuel as was the practice in the U.S.A. and other countries.

He referred to the methods suggested in the Papers for reducing smoke from running sheds and said he thought direct steaming and the use of smokeless fuels for lighting up were one answer to the problem but doubted if this could be achieved and maintained and suggested that, in order to reduce the appalling smoke pollution in the neighbourhood of running sheds, the method of connecting the smoke troughs to a tall chimney with fan extraction should be adopted. He would have liked a resolution from the Conference on these lines.

He also thought something should be done by the Railways to bring about the use of smokeless fuels in railway yards, offices and canteens and said the Railways seem to be wedded to raw coal because they have to burn it in their locomotive fireboxes. If they would use gas or coke instead on those small fires there would be a great improvement in atmospheric conditions.

S. H. Richards (Fuel Research Station, Greenwich) said that the Fuel Research was in full agreement with both authors in their views on the causes and the methods for the prevention of railway smoke, particularly with regard to the use of secondary air. As was generally well known a great deal of work had been carried out at Greenwich on the reduction of smoke from coal-fired boilers. During the war—at the request of the Admiralty—special devices were developed to eliminate the smoke emitted by coal-fired merchant ships, and subsequently the work had been successfully extended to the reduction of smoke from industrial hand-fired, natural-draught, shell-type boilers. Work is now being carried out with a view to the development of smoke eliminators suitable for forced-draught, hand-fired boilers of the Lancashire type and hand-fired vertical boilers.

The importance of secondary air could not be over-emphasized. When the work on smoke eliminators for merchant ships was commenced it was surprising to find that many natural-draught ships' boilers had no provision at all for the admission of secondary air, other than that which leaked in round the fire doors, and even today, despite all that has been said and written on this subject, certain types of small vertical boiler are still being manufactured with inadequate arrangements for admitting secondary air.

The design of steam jet injection for secondary air developed in the U.S.A. by the Battelle Memorial Institute had been tried out at the Fuel Research Station and had proved quite effective. As Mr. Skeat had stated, however, the idea was not a new one, in fact a patent for steam jets over the fire was taken out as long ago as 1838 !

Referring to the smoke emitted from locomotives during lighting up, Mr. Richards said that some time ago members of the engineering staff of the Fuel Research Station had visited locomotive sheds in the London area and had been appalled at the conditions prevailing. It was apparent that the amount of smoke produced could depend a great deal on the method used in placing the fire lighters and the coal in the fire-box. A skilled man could light up the fire with much less smoke than one with little experience. It was essential, therefore, that recruits should receive adequate instruction in the best methods to be adopted.

The problem of reducing smoke from railway locomotives bore certain resemblances to another type of smoke nuisance frequently encountered, namely that from river boats, in that in both cases small boilers are being worked at heavy load. It was appreciated that the type of coal now being supplied to river craft was sometimes not the most suitable for their purpose, and that for reasons of navigational safety it was necessary to maintain full steam pressure at all times, nevertheless, it was felt that although the problem was admittedly a difficult one, by suitable application of the knowledge now available some measure of improvement should be possible.

James Law (Sheffield) said he had been particularly interested in the papers presented for this session, because he did not think there was a town or a village in Britain that did not suffer from that kind of nuisance to a greater or lesser degree.

Mr. Skeat, in his very comprehensive paper, gave a vivid picture of what was taking place, and it was pleasing to note that he did not offer any excuse for the nuisance from " running sheds " where locomotives are starting up from cold. He advocated the universal use of direct steaming for this purpose, and there was no doubt about the benefit that would accrue, both to the workers in the running sheds and people residing in the neighbourhood, if these measures were adopted. It was hoped that a resolution from the Conference, to this effect, would be approved.

The boiler efficiencies given in both the papers as 80 per cent. required a bit of adjusting, for the draw-bar efficiency of a modern locomotive was only about 7 per cent., and the amount of excess air passing through the tubes of a locomotive running at high speed, ruled against an efficiency *approaching anything like that* figure. In addition, being hand-fired and charging—" light and often " reduced furnace temperature very much. Mr. Skeat thought that smoke during shunting operations was exaggerated, but if he observed what took place at any large marshalling siding he would change his views. Mr. Skeat's most interesting section was where he dealt with alternative fuels and alternative forms of motive power, and this is where it was hoped some valuable information would be given with regard to long term as well as short term policies.

They had heard a great deal about the electrification of railways, and anyone who had travelled about the country would undoubtedly plump for electric propulsion every time, both for comfort, cleanliness and efficient working. Apparently this electrification was still too far away even to think of as a long-term policy, and if that was so, well the

British Railways should make greater efforts in the way of improving their steam propulsion. Steam generation, both at sea and on land, had advanced during the past twenty years. Most of the boilers were oil-fired or mechanically stoked, and the number of hand-fired solid fuel boilers was very much in the minority. In other countries oil firing and mechanical stoking were in regular use on locomotives. Footplate firing was a skilled and laborious job, and the young men of today were not too keen to take up this work. Could they be blamed? Mr. Skeat stated that if half the attention accorded to the diesel locomotive was given to the steam locomotive, the latter would achieve the same records as the former, and whilst not entirely agreeing, it was thought that many of the existing locomotives could be adapted for mechanical firing with great advantage to the British Railways, the public they served, and the men who operated them.

Mr. Law entirely agreed that much in the way of minimizing nuisance from locomotive smoke could be done by co-operation between the locomotive superintendents and the Local Authority Officers, and experience had shown that there was ample room for improvement, particularly in terminal towns, where running sheds and marshalling sidings were operating.

H. Hornby (Senior Sanitary Inspector, Batley), after drawing attention to the poisonous atmosphere which pervaded many of our bigger railway termini, reminded the Conference that here was a point of very special interest: perfect apparatus, highly skilled men, opportunities for education, and yet the nuisance still continued! In the wider industrial field it had often been his experience that on inviting the management of a firm to take a look at their chimney at a moment when it was offending badly, the black smoke emission was immediately stopped, only to be followed by excuses why it could not be stopped before! What, he inquired, was the correct balance between education and compulsion? Obviously, a reasonable amount of the latter was still necessary if the experience of the railways was any criterion. He was for education now and all the time, but in his opinion there was also a case for a sufficiency of officers to bring pressure to bear upon those who acted in total disregard of the public interests.

H. H. Cash (Yorkshire Electricity Board) said that the outstanding feature that had occurred to him while visiting the demonstration coaches and witnessing the film shows on the education and training of locomotive firemen, was the relatively crude methods shown for the firing of locomotive boilers as compared with Power Station practice.

F. E. Simon, Professor of Thermodynamics in the University of Oxford, in his Paper to the Royal Institution on November 19th, 1948, stated that "It is well known that the locomotive is one of the greatest offenders in wasting fuel, having an average efficiency of only about 5 per cent." As a one-time Power Station Engineer who had been used to witnessing not only mechanical handling of coal, but also the automatic regulation and control of combustion, this quotation, taken in conjunction with the demonstration films, appeared to be linked. It did not appear possible for the human element to be sufficiently and consistently conscientious to equal mechanical methods. If one objection to mechanically controlled stoking was that of the variations in power demand, which Mr. Cash would agree were somewhat more rapid and greater than those met in Power Station practice, it would indeed be surprising if modern ingenuity could not design control equipment to vary combustion conditions so as not only to cope satisfactorily with variations of steam pressure, but also to do this with a minimum of smoke emission.

In regard to coal quality which had been mentioned several times as a contributing factor in railway smoke, as far back as the 1920's Mr. Cash recalled that it was usually the practice of the Boiler House Stokers adversely to criticize the coal they had to use and to blame the Power Station management for buying it. Nowadays it appeared to be fashionable to put the onus on to the National Coal Board. He reminded

the assembly that provided one had a boiler with the correctly designed combustion chamber and grate, then almost any quality of coal could be burned efficiently, and with a minimum of smoke. For example, boilers in both Russia and Eire had been designed for burning peat. The major point at issue was, of course, that coal deliveries should be consistent in the quality that the boiler was designed for, and then efficiency and smoke reduction should automatically follow.

A question raised by an earlier contributor to the discussion in relation to railway electrification was of interest to the speaker. As a representative of the Yorkshire Electricity Board, Mr. Cash could say that he had visited the workings on the new Woodhead Tunnel within the past month. This was a new tunnel of 16,000 feet in length designed to take an electrified line for the very heavy traffic between Manchester and Sheffield, and for which the Electricity Boards were supplying the energy. For the information of delegates he could say that the work was proceeding apace, the pilot tunnel of 12 feet diameter being already about 50 per cent. complete and the work of providing the necessary electrical substations was already well in hand. When this electrified line came into operation, the heavy smoke nuisance at present in evidence on this line would, of course, be largely eliminated.

Alderman A. P. Holden (Battersea) asked Mr. Bennett whether it was not a fact that on the Southern Section, British Railways, the express locomotives of the Merchant Navy class were not fitted with damper control, therefore dampers could not be closed, and that as a consequence drivers had had little or no control over smoke emission from their locomotives. If this was the case, could nothing be done to remedy an obvious constructional defect? The residents in his locality suffered considerable nuisance by reason of their proximity to Waterloo Station, upon leaving which locomotives were bound to emit large volumes of smoke in raising speed.

He further asked Mr. Bennett whether it was not possible for the Railway Executive to appoint additional smoke inspectors in the London area. He knew that some years ago the knowledge that inspectors were liable to be undertaking observations at any time had an effect upon drivers and firemen, and he wondered whether the 100 or so smoke inspectors, scattered throughout the whole system of British Railways was as adequate a check as formerly.

In conclusion he, as an engine driver, appealed to Mr. Bennett in the matter of improvement classes. Could not these with advantage be held in normal working time? It would be, he was sure, a source of great encouragement to younger men to be given the opportunity of attending these in other than their own free time as at present. He suggested that the Railway Executive would be making a real contribution to smoke abatement in giving facilities of this nature.

Mr. T. Henry Turner (Doncaster) said that the Society was fortunate in having two such good papers on Railway Smoke. He had heard Mr. Skeat speak on many subjects at meetings of the Institution of Locomotive Engineers, and his paper was written with a background of much personal knowledge of railway operation. In Mr. Bennett they had the official representative of British Railways. He thought they should ask the Executive of the Society to write to Sir Eustace Missenden thanking him for taking up the initiative of raising the question of smoke and atmospheric pollution in his paper to the Institute of Transport and for the message from the Chairman of the Railway Executive which Mr. Bennett had read to the Society that afternoon. The fact that the head of all the British Railways had sent that message should be regarded as a landmark in the history of the work of the Society and the lead taken in this way by their Chairman would no doubt be noted by many railway officers.

As regards the question of shunting raised by the delegate from Corby; he suggested that any works should consider the possibility of using fireless locomotives for works shunting. They

were cheaper to maintain than diesel or diesel-electric, and could be recharged with steam from the works boilers in as little as a quarter-of-an-hour. They would produce no fire risk and leave no dirty ashes, and require the minimum of grades of labour to maintain them.

Councillor J. Wallace (Seaham U.D.C.) defended the miner and the National Coal Board on the question of dirty coal. He argued that the rapid increase of mechanization in the mines resulted in vibration causing the strata to be disturbed to such an extent that the miner was unable to keep his coal clean. The N.C.B. were doing their best by better lighting in the mines and the use of more efficient cleaning plants on the surface. The miner or the N.C.B. should not be blamed. The blame should be laid to the demand for coal so essential at the present.

Councillor A. Mead, C.C. (Chairman, Kirkby-in-Ashfield Health Committee) said that Kirkby-in-Ashfield suffered from two serious forms of smoke nuisance: (a) from railway locomotive engines, and (b) from colliery chimneys and spoilbanks.

Regarding (a) he said that the centre of the trouble was an engine shed and its adjoining standings, which ran alongside a main road. It was not an uncommon sight to see 60 locomotives pouring a particularly unpleasant and unhealthy smoke across the main road and into the adjoining houses. A thick fog, or what the Americans called a "smog" was a permanent feature of this part of Kirkby in the winter-time.

He understood that the only way to deal with this matter was by means of the Railway Clauses Consolidation Act (1845), which was as old and as out-of-date as it sounded. In fact, it was practically unworkable. The Local Authority could not take action themselves, but must rely on a "common informer," who received half of the penalty awarded, and who presumably had to bear half of the costs if the case was lost.

The Act stated that "every locomotive steam-engine shall be designed so as to consume its own smoke"—a thing which the modern railway engine did anyway. To get a conviction, the nuisance must therefore be proved to have been caused through the default of the Company or its servants.

Meanwhile, he stated, this serious threat to the health of Kirkby's inhabitants went on, and he considered that the Conference should urge the Minister to look into this antiquated piece of legislation immediately, with a view to replacing it by a new and workable Act.

Councillor K. A. E. Gregg (Tottenham) prefaced his remarks by informing the Conference that he was a locomotive fireman, and had been one of the offenders causing smoke. He stated that a previous speaker was wrong in assuming that smoke could not be avoided by shunting engines. One method was by a system known as "side firing."

With reference to the remarks made about bad coal, admittedly some was bad, in fact, the men had a name for it and it was *not* coal; but on the whole, the coal was pretty fair material.

Referring to the papers presented, he would like to compliment Mr. Skeat on a paper that was really down to earth. In the opinion of Councillor Gregg, as a practical locomotive man, Mr. Skeat certainly knew what he was talking about, but, for him to suggest that the men have lost their pride in their craft was a mistaken belief. The men *had* a pride, and *wanted* to have a pride in their craftsmanship, but, by virtue of dirty engines, lack of tools, frustrating delays, lack of recognition, etc., this pride was suffering many severe blows.

The remarks made by Mr. Bennett were greatly appreciated. Too often in life today one heard say that management were all too willing to slate the workers and vice versa, therefore, it was grand to hear Mr. Bennett back up the workers, and take Mr. Skeat to task over his remarks regarding the unwillingness of the older men to help the younger men.

Councillor Gregg had to thank many of the older men for the help and instruction he had been given. His interest in the locomotive was created by these

men. When groups of enginemen conversed together, argument invariably ensued on the locomotive and, when drivers and firemen had spare time, more often than not it was spent in talking about engines.

In the opinion of the speaker, Mr. Bennett's paper was as good as one could expect from one as skilled in his craft as Mr. Bennett, but, on one point, he felt that Mr. Bennett's enthusiasm had overcome his facts. Whilst it was true that every recruit in the locomotive department goes through a systematic course of examination, the training and instruction left much to be desired. The only way a man could get systematic training was by going to Mutual Improvement Classes and, as they were run by the men and a man had to attend in his leisure time, only the keen enthusiastic man attended ; and it was not the keen enthusiastic man who was the smoke offender.

Cleaners on entering the service were allowed to learn their future craft haphazardly and many lost their enthusiasm by virtue of the lack of opportunity to learn systematically in decent surroundings, by qualified, practical men. The speaker felt that the possible answer was by men being booked to attend classes for instruction. Only then could men be justly examined in their knowledge of the locomotive and the rule book.

M. G. Bennett, in his closing remarks, said that it was encouraging to find that so many people advocated just those steps to mitigate smoke which British Railways were in fact putting into operation. The policy on most of the matters raised in the discussion was explained fully in his paper. There were, however, a few points about which a number of people spoke that he would explain in more detail.

The educational scheme had attracted much interest. He was glad so many people had visited the instructional train and seen for themselves the sort of training which was being given and the keenness and energy being put into it. Some speakers seemed to be under the impression that almost the whole of the training was done in the men's own time. On the contrary, the work of the growing number of smoke inspectors and firing instructors was done actually on the job during working hours, apart from the assistance given to the Mutual Improvement Classes, which was the men's own organization and valued as such.

Mechanical stoking had been mentioned by a number of speakers, and a misleading analogy made with electric power stations. The economics were quite different. No staff saving on the footplate would be possible with mechanical firing, and it would involve a radical change in the type of fuel required by the Railways which might embarrass the N.C.B. But apart from this it was extremely doubtful whether mechanical firing would reduce smoke. It was expecting too much of a mechanical device to follow the extremely rapid fluctuations of load in a locomotive (which were much more violent than in a power station) as efficiently as a trained fireman, who could, and did, even anticipate many of the changes which occurred. He had seen and travelled on the footplate of a number of engines fitted with mechanical stokers in many parts of the world and they were certainly no better than our locomotives in the matter of smoke. While on the subject of the locomotive he would like to correct an impression given by Mr. Skeat, that the standard of maintenance of their fleet of locomotives had suffered since the war. This was hardly compatible with the fact that each year more engine miles were being run with fewer engines.

Mr. Bennett again thanked the Society for the opportunity to explain the policy of British Railways in the matter of smoke, and to describe the vigorous action which was being taken ; and for the very friendly and patient reception of his paper.

W. O. Skeat, in reply to Mr. Wilkinson, expressed his sympathy with those who objected to the firing of shunting locomotives when they happened to be inside the buildings of a steel works. He thought that oil-fired locomotives might give good results for the duties which Mr. Wilkinson had in mind ; but he

considered that the provision of over-fire air jets would be even more satisfactory, and would avoid the need for imported oil fuel. He would, however, remind Mr. Wilkinson of the point raised by Mr. T. Henry Turner that fireless locomotives might be the best solution.

He was very glad to see his old friend, Mr. Saunders, who was a fellow-apprentice with him in the Doncaster works of the former Great Northern Railway. He was aware of the experimental practice of making photographic records of a fireman's movements ; but a more sinister use of photography in days gone by involved the posting of an inspector, with camera, at a strategic point, say on an over-bridge, so that he could record any bad cases of black smoke emission. Efforts were always made to show the number of the engine in such prints, so that if the fireman concerned denied the charge of making black smoke, he could be confronted with the tell-tale photographic print.

He thought that mechanical stokers deserved more attention than they had so far received in this country. In the U.S.A., he understood that it was a statutory obligation for railway managements to provide mechanical stokers on all engines having over 50 sq. ft. of grate area. He thought that this limit might be lowered to about 42 sq. ft., at any rate for future construction in Great Britain. Mr. Saunders' support for the suggestion, made in the paper, of connecting smoke troughs in running sheds to a tall chimney, with fan extraction was most welcome.

Councillor Gregg's remarks were of the greatest importance, since he spoke with the authority of one directly concerned with the problem. Councillor Gregg could not accept the charge made in the paper, that some drivers were unwilling to help and advise their firemen. He would be glad to stand corrected by Councillor Gregg in this matter ; it seemed that things had improved in this respect. Such cases, though not common, were, however, unpleasant enough to be worth noting when they did occasionally occur. But there was no intention, in the paper, to suggest that it was common for a fireman to find his driver unhelpful. With regard to the profit to be derived from instruction classes, he fully realized that it varied from one man to another ; but Councillor Gregg by inferring that the keen men attended them, whilst those who were *not* interested stayed away, had himself admitted that there was a certain lack of interest to be found.

He did not think that any special comment was called for by the interesting contribution from Mr. Richards, whose emphasis on the value of proper instruction to shed staff engaged on fire-lighting was to be noted.

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NOTES

PREVIOUS CONFERENCES OF THE SOCIETY

1929	BUXTON
1930	LEICESTER
1931	LIVERPOOL
1932	NEWCASTLE-UPON-TYNE
1933	SHEFFIELD
1934	GLASGOW
1935	BRISTOL
1936	LONDON (Science Museum)
1937	LEEDS
1938	CARDIFF
1943	LONDON*
1945	LONDON*
1946	BRIGHTON*
1947	EDINBURGH*
1948	CHELTENHAM*

* *"Proceedings" still available. See Guide to Publications, or at Conference Bookstall*

NATIONAL
SMOKE ABATEMENT SOCIETY

PROGRAMME

of the

SIXTEENTH ANNUAL CONFERENCE

HARROGATE

Wednesday - 29th September

to

Saturday - 1st October

1949

PROG

<table>
<tr><th></th><th>WEDNESDAY 28th SEPTEMBER</th><th>THURSDAY 29th SEPTEMBER</th></tr>
<tr><td>MORNING</td><td></td><td>ROYAL HALL

10.00 Chairman : Dame Vera Laughton Mathews, D.B.E. (President Designate)
Official Welcome by the Worshipful the Mayor of Harrogate.

10.30 Progress Reports.
(see Advance Papers)
Discussion, opened by the General Secretary.

12.00 Close of Session.</td></tr>
<tr><td>AFTERNOON</td><td>LOUNGE HALL, ROYAL BATHS

3.30 Presidential Address. By the Rt. Hon. Lord Simon of Wythenshawe, LL.D., retiring President.

4.00 Annual General Meeting
(See separate notice and Agenda)
At the close of the meeting Tea will be served, by invitation of the President and Executive Council.</td><td>ROYAL HALL

2.15 Chairman : John W. Beaumont, F.R.S.I., F.S.I.A ,
(Deputy Chairman, Executive Council)
Paper : The Problem of Burning Colliery Spoilbanks.
By J. Carr, M.Inst.F. (Area Chief Scientist, National Coal Board)
Discussion, opened by W. A. Damon, C.B.E., B.Sc. (Chief Inspector of Alkali, &c., Works).

4.15 Close of Session.</td></tr>
<tr><td>EVENING</td><td>LOUNGE HALL, ROYAL BATHS

8.30 Reception by the Worshipful the Mayor of Harrogate.
(By Invitation - See "Arrangements" and Reply Form.</td><td>4.45 Coach Tour to Fountains Abbey.
(See "Arrangements" and Reply Form)

6.45 Coaches due back at Harrogate.</td></tr>
</table>

AMME

FRIDAY **30th SEPTEMBER**

ROYAL HALL

Chairman : Charles Gandy
(*Chairman, Executive Council*)

10.00 **Address by Arthur Blenkinsop, M.P.**
(*Parliamentary Secretary, Ministry of Health*)

10.30 Address : **"The Work of the Fuel Research Station, D.S.I.R."**
By Dr. A. Parker, *Director of Research*

Questions and discussion.

12.00 Close of Session.

ROYAL HALL

Chairman : Alderman J. S. Tennant,
(*Chairman, Health Committee, Harrogate*)

2.15 Paper : **The Case Against Smoke : an Outside View.**
By E. Sinkinson, B.Sc. (*Lecturer in Fuel Technology, University of Leeds*)
Discussion.

4.15 Chairman : Charles Gandy
(*Chairman, Executive Council*)
Vote of Thanks, etc.

4.30 Close of Session.

PRINCE OF WALES HOTEL

7.30 **Conference Dinner.**
(*See "Arrangements" and Reply Form*)

SATURDAY **1st OCTOBER**

10.00 **Coach Tour to the Yorkshire Dales.**
(*See "Arrangements" and Reply Form.*

3.30 (*approximately*) Coaches due back at Harrogate.

ARRANGEMENTS AND GENERAL INFORMATION

Meeting Places

The events on Wednesday, 28th September, including the Annual General Meeting and the Mayor's Reception, will be held in the Lounge Hall, Royal Baths. The Conference Sessions on Thursday and Friday, 29th and 30th September will be held in the Royal Hall.

Other Documents and Advance Papers

On or about the 7th September members and delegates registered as attending the Conference will receive Advance Proof copies of the papers to be presented, together with a Guide to Harrogate, Conference Delegates Facilities Card, Conference Badge and, where applicable, tickets for the Conference Dinner, Invitation to Reception, and tickets for the Tours, A printed copy of the Presidential Address will not be distributed before the Conference, but copies will be available at the bookstall after the address has been given.

Reply Form

Kindly complete and return the enclosed Reply Form as soon as possible, in any case not later than 31st August, 1949.

Reception

Invitations to the Reception on Wednesday evening will be issued by the Worshipful the Mayor of Harrogate. Those wishing to receive an invitation should indicate this on the Reply Form. Day dress will be worn.

Conference Dinner

An informal dinner will be held at the close of the Conference on Friday evening, 30th September, at the Prince of Wales Hotel. The price of each ticket will be 12s. 6d. inclusive of gratuities but exclusive of drinks. Application for tickets should be made on the Reply Form and the remittance enclosed. Day dress will be worn.

Conference Badge

The wearing of the badge, to be forwarded later, is requested in order to assist introduction to other delegates.

Discussions

Those wishing to speak in discussions are asked to send their names to the platform during the session concerned. In view of the fact that discussions at smoke abatement conferences have invariably to be cut short, all speakers are requested: (*a*) to condense their remarks as much as possible and to note the signals on the platform Speech Controller; and (*b*) to confine their remarks strictly to the specific questions raised in the paper being discussed. The time allowed for contributions will normally be limited to 5 or 3 minutes.

Resolutions

The following procedure has been approved by the Executive Council:

(*a*) Any resolution it is desired to bring before the Conference must be submitted for the approval of the Executive Council and received by the General Secretary at the offices of the Society in London not later than 16th September, 1949. 15 Sep

(*b*) Resolutions relating only to subjects under discussion at the Conference can be accepted, and would be moved during the discussion In the appropriate session.

List of Delegates

A list of delegates attending the Conference will be printed and copies will be available for distribution from the Conference Bookstall.

Proceedings

The papers, discussions, and any resolutions will be subsequently issued in volume form as *The Proceedings of the Harrogate Conference 1949*. A copy will be forwarded free of charge to all registered delegates, and extra copies will be available at 3s. 6d. each, by post 3s. 8d.

Those who take part in the discussions are asked to send a condensed copy of their remarks, *in reported speech*, to the Secretary not later than 14th October, 1949. Verbatim reports of speeches will not be taken.

Bookstall

There will be a bookstall of the Society's, His Majesty's Stationery Office, and other publications.

Motor Coach Tours

The following have been arranged:

(*a*) *Fountains Abbey, Thursday, 29th September, 1949* Coaches will leave Harrogate at 4.45 p.m., spend approximately one hour at the Abbey and return to arrive back at Harrogate at 6.45 to 7 p.m. Tickets which will include the cost of admission to the Abbey and gratuities, will be issued for this visit at 5s. each.

(*b*) *Yorkshire Dales, Saturday, 1st October, 1949.* Coaches will leave Harrogate at 10 a.m. proceeding *via* Wharfedale to Kettlewell for lunch and returning *via* Burnsall arriving back in Harrogate at 3 to 3.30 p.m. The cost of this tour will be 15s. including lunch and all gratuities.

Delegates wishing to take part in either or both of these tours should make their applications on the enclosed Reply Form and enclose remittance.

Volunteer "Couriers" from the "Friends of Harrogate" will accompany both tours.

Inquiries

Inquiries about arrangements and request for information should be addressed to the Society's offices up to Monday, 26th September, 1949, and during the Conference at the Royal Hall, Harrogate. The Society cannot undertake Hotel, etc., bookings on behalf of delegates, but if any difficulty is experienced in obtaining accommodation inquiries may be addressed to W. W. Baxter, Conference Secretary, Information Bureau, Harrogate. Lists of Hotels and Boarding Houses for Conference Delegates are available from the Society.

1950 Conference

An announcement will be made during the Conference about the place of meeting for the 1950 Conference.

ARNOLD MARSH,
General Secretary.

National Smoke Abatement Society,
Chandos House,
Buckingham Gate,
Westminster, S.W.1.

Telephone: ABBey 1359.

NATIONAL

SMOKE ABATEMENT SOCIETY

Proceedings
of the
Blackpool Conference
1951

Price 7/6d.

CHANDOS HOUSE
BUCKINGHAM GATE
LONDON, S.W.1

Guide to Publications

This is one of the many publications of the National Smoke Abatement Society. For a complete list write to the Society for its current Year Book. This contains a Guide to Publications on Smoke Prevention and Allied Subjects, which includes, in addition to the Society's own titles, particulars of other books, reports and papers, any of which may be purchased from the Society. The list is classified according to subject—the Law, Conference Proceedings, General, Historical, Smoke Prevention Administration, Industrial Smoke, Domestic Heating, Technical and Scientific, and Industrial Pollution.

NATIONAL SMOKE ABATEMENT SOCIETY

Proceedings of the 18th Annual Conference, Blackpool

26th to 28th September, 1951

Chandos House, Buckingham Gate, London, S.W.1

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Blackpool Conference

SUMMARY OF EVENTS

THE conference was officially opened by His Worship the Mayor of Blackpool (Councillor Joseph Hill, J.P.) at the Winter Gardens on the morning of Wednesday, 26th September, with the President, Dame Vera Laughton Mathews in the Chair. Her Presidential Address was then read.

The Annual General Meeting of the Society followed, with Mr. Sidney N. Duguid, Chairman of the Executive Council, in the Chair. The election of two new Vice-Presidents, Alderman F. W. Perry of Smethwick, and Dr. R. Lessing, was announced, followed by the announcement that Alderman Professor F. E. Tylecote had been elected as the new President. Alderman Tylecote was introduced and welcomed by the Chairman, and briefly responded. In the afternoon the 2nd Des Voeux Memorial Lecture was read by Dr. J. Bronowski, with the President, Dame Vera Laughton Mathews in the Chair. Members of the conference were privileged to attend a Civic Reception, with dancing and cabaret, during the evening.

On the following morning, Thursday, 27th September, the session on "The Smokeless Operation of Small Steam Raising Plant" was held, with Mr. W. A. Damon, Chief Inspector of Alkali, etc., Works, in the Chair. During the afternoon visits were paid to the Marton Gasworks of the North Western Gas Board, and to the Ribble Generating Stations, Preston, of the North West Division, British Electricity Authority. An informal evening party was held in the Savoy Hotel for a limited number of members.

On Friday, 28th September, the morning session was on "Policies for the Prevention of Industrial Air Pollution," with Sir Ernest Smith, Hon. Treasurer, in the Chair. In the afternoon the subject was "Smoke Prevention in the Home—from the Woman's Viewpoint." In the absence of the Chairman announced in the programme Alderman Mrs. Julia Engwell, Chairman of the Public Health Committee, Barking, very kindly presided.

The session and conference concluded (with Mr. S. N. Duguid in the Chair) with the adoption of the resolutions recorded at the end of this volume, a general vote of thanks proposed by Mr. J. J. Matthews, Chairman of the Conference Committee, and an invitation from the Lord Mayor to hold the 1952 conference in the City of Portsmouth conveyed by Mr. W. F. Appleton, Chief Sanitary Inspector. The vote of thanks included expressions of appreciation addressed to authors and sessional chairmen, and to those in Blackpool who had made possible so successful a conference; namely, His Worship the Mayor, the members of the Council, Mr. W. Foster, Director of Attractions and Publicity, Mr. Harry Priestley, Chief Sanitary Inspector, and the management and staff of the Winter Gardens.

PRESIDENTIAL ADDRESS

by

Dame Vera Laughton Mathews, D.B.E.

I FEEL that I have been extremely lucky to have been President of this Society during two specially momentous years. Last year was the Society's " coming of age " : this year we celebrate the Festival of Britain. In my last address I tried to give a slight survey of the chief events of the history of the Society, and it seems appropriate in this Festival year, when every kind of achievement is being noted in terms of 1851 and all that, that we should look at the position today in comparison with a hundred years ago.

Not that the cause of smoke abatement dates only from 1851. It is now 645 years since Parliament first concerned itself with the smoke nuisance. So long ago as the year 1306, as a result of public demonstrations and petitions, a royal proclamation prohibited articifers from using coal in their furnaces, but the decree seems to have had little effect even though it is reported that one offender was executed.

It is true, however, that about the middle of the last century, when the smoke nuisance had reached alarming proportions, the matter became one of serious public consideration both in and out of Parliament.

At the time when the great glass palace was being erected in Hyde Park for the 1851 Exhibition, London was approaching the peak years of its smoke problem. Indeed one can but admire the courage of Paxton in designing an all-glass building and wonder how they kept it clean and transparent, and how much it cost to do so. Even now a day's fog may cost Kew Gardens an extra £100 in glass-cleaning. How much has the smoke and grime of London cost the many Exhibitions on view this year of 1951 ? Certainly a figure which might shake the complacency of those uninformed members of the public who say, " Why a Smoke Abatement Society ? The days of peasoup fogs are over."

Certainly there have been great improvements during these hundred years, largely due to the triumphant advance of gas and electricity, but due also to a more enlightened public opinion for which the educational work of this Society is mainly responsible.

The point of view of a hundred years ago is clearly indicated in the evidence given in 1845 before a Select Committee set up to enquire into " the Means and Expediency of Preventing the nuisance of SMOKE arising from Flues or Furnaces." All witnesses were much of the same mind. The prevention of smoke was not practicable and in any case the matter was not of much importance. The evidence, mostly from ironmasters and distillers, is an illustration of the lamentable habit of the majority of human beings of accepting unnecessary burdens and hardships simply from inertia or the lack of knowledge of better things. Certainly in this case, the witnesses were those who would themselves have had to undertake trouble and expense in the matter, which may account for their complacency.

Mr. James Scott Smith, a distiller of Whitechapel though " not averse to the experiments being made for the consumption of smoke " thought that smoke was " not prejudicial to the extent which the public suppose." Mr. Alfred Watney, a distiller of Wandsworth, mentioned efforts that had been made with various patents " without the least saving of fuel and without any consumption of smoke." Mr. George Smith, distiller of Whitechapel, was even more outspoken. " I do not consider it a nuisance ; it is a question certainly of a degree of dirt, and soils everything that stands around it, no doubt ; but, as regards an inconvenience, a person who has been in London all his life, as I have, makes up his mind to a certain amount of inconvenience."

As a result of this Committee's recommendations, smoke abatement clauses referring to industrial smoke were included in subsequent legislation, though we do not know with what result. The Committee considered that it was not practical to deal with domestic smoke by legislation, which shows that in that matter present-day thought has advanced

considerably.

Following the severe fogs of 1873 and 1880, the first smoke abatement exhibitions were held in London and subsequently in Manchester and an *Exhibition Review* issued. I was intrigued to see that there was a woman contributor, and although the men's contributions are signed, hers appears in modest anonymity "By a Lady." Which reminds me that it was just about this period when a few brave women had the temerity to start speaking in public and that in the House of Commons a member referred to speeches "by the wives of two members of this House. I will not add to their shame by mentioning their names."

It would be nice if the enterprising "Lady" of 1882 could have foreseen this meeting with a woman President addressing this august assembly.

Great advances have been made since the day when it was considered that nothing could be achieved in regard to domestic smoke by official action. The domestic problem is as serious as the industrial one and it is rightly in the forefront at this Conference by the devotion of a whole session to a discussion on smoke prevention in the home.

Today all new houses constructed by Local Authorities with Government subsidies are fitted with improved solid fuel appliances which, in almost every case are suitable for burning smokeless fuels. The fact that the efficiency of these appliances is markedly higher than that of the ordinary stool-bottom grate means that even though bituminous coal might be used with them, the amount required will be less, and in consequence the production of smoke will be smaller.

All appliances, and particularly the modern improved appliances, give higher efficiencies when using coke than when using bituminous coal. The overall efficiency of an open grate with back boiler and convection air heating is approximately 55 per cent. with coke and 40 per cent. with bituminous coal. An openable stove will show an efficiency of 60 per cent. with coke and 45 per cent. with bituminous coal.

New houses will have the means of being smokeless and efficient in their use of fuel, but there remains the large number of existing houses where the domestic fire is both inefficient and smoke-producing. To help the occupants of these houses, coke grates have been developed which can be fitted in existing fireplaces and thought has also been given to appliances which can stand in an existing fireplace and, because of their higher efficiency, will considerably reduce smoke production.

The contention is often made that bituminous coal must be used on account of the scarcity of coke and other smokeless fuels. A recent issue of the B.C.U.R.A. magazine, in speaking of the improved type of space-heating units, states: "One point of some importance is that most of these units must continue to use bituminous coal for some years to come, the ratio of coal to coke available for the domestic market being about 10 to 1."

I am not denying that much could, and should be done in the production of more smokeless solid fuel. Nevertheless, this argument concerning the availability of coke, which is frequently advanced by the coal marketing interests, is fallacious.

The facts are that the amount of house coal available is 30 million tons a year. The gas industry makes available 10 million tons of coke a year, but of this quantity only about one-quarter to one-fifth finds its way at present to the domestic user; the remainder is sold to industry or for the heating of commercial or public buildings. On many of these larger installations it is more possible to burn coal smokelessly than on domestic installations and there is, therefore, still every reason to urge people to use smokeless solid fuel in their homes. The use of coke as a domestic fuel would not be limited by shortage of supplies until it increased to three or four times the present figure.

It should also be remembered that 1½ million tons of coke is now being used by the gas industry for the making of water gas, which would not be necessary if more coal were available. The limit of capital expenditure laid down by the Treasury also handicaps the coke industry. As one example, more screening plant would enable a considerable amount of what is now sold as coke breeze to be made available for the domestic market.

In more normal conditions, a further 2½ million tons of coke could be made available for the domestic market.

The gas industry realises its responsibilities to the domestic consumers who are now installing modern solid fuel appliances and plans to make, progressively each year, more coke available for the domestic market. As you know, coke has to be marketed as the Ministry of Fuel dictates, and the domestic market at present has the last call on supplies. Looking to the future it would appear that it should have the first, in order that the

recommendations of the Simon Report in regard to space heating by smokeless solid fuel may be implemented.

I repeat also what I said in my Address to you last year that this recommendation of the Simon Report would be greatly helped if the National Coal Board would adopt a gradual policy of supplying coal at a cheaper rate to the carbonizing industries which produce smokeless fuel, and making those domestic consumers who insist on burning coal in the raw state pay extra for their hobby.

After all, we cannot eliminate from the argument this clinging to the traditional British open coal fire in which both men and women are equal culprits—undeterred by the fact that the clinging has to be physical as well as mental, in order to benefit from what is avowedly the most inefficient form of space heating.

In the special Festival publication of *Punch* there is a page of illustrated French nonsense verses and limericks. One picture entitled " Emulation Internationale " shows Mr. Punch proudly displaying to a Frenchman in front of an open fireplace, a poker and a coal-scuttle ; and this is the verse :

Oui, Français, votre patrie est belle,
Et chez vous le soleil étincelle,
Mais l'on n'a pas chez vous
Ces deux objets si doux.
Le Poqueur et la Côle-escoutelle.

holding them out admiringly, as though they were a match for any sunshine.

Of course, I know that with an optimistic temperament one can turn nearly any handicap into a compliment. I remember visiting the Orkneys and Shetlands during the war, and although those windswept islands have a grandeur of their own, the entire absence of trees is generally regarded as a drawback. However, when I was motoring there one day, the local driver uttered the following gem : " The great thing about the Shetlands," he said, " is that there are no trees to obstruct the view."

Well, I think even that loyalty is put in the shade by the Englishman proffering his Poqueur and Côle-escoutelle as beloved national amenities. And I think *Punch* is pretty accurate as a rule in satirising public opinion.

I know when I visited Germany earlier this year (where incidentally I did not see a single open fire) and gave them the figures for coal being burnt here in the raw state, they exclaimed, " But that is terrible." In Germany half the total amount of coal is used for gas and coke.

People say that with our grey climate we need the colour and cheerfulness of an open fire. They should reflect that without smoke we should have the good cheer of clean paint and bright fresh surroundings.

London for once has been gay and colourful this summer. To the Londoner and regular visitor it has been a delightful contrast with the familiar grubbiness (though there is still plenty of that) but it has been achieved only at considerable cost in cleaning and new paintwork. And the brightness will not last long in the smoky air. The designers of the South Bank Exhibition became seriously worried by the relentless attack of soot and grime and acids that make up London's smoke. Mr. Misha Black, one of the chief designers of the South Bank Exhibition, has said that deposits of dirt and dust in that area are so heavy as to have made proper maintenance almost impossible in terms of reasonable expenditure, and a large proportion of our architectural effects have been vitiated by soot and grime which lie heavily on all exposed surfaces.

Because of the South Bank Exhibition and the Festival Gardens at Battersea, arrangements were made this summer to reduce the shocking smoke of Thames tugs and other craft by supplying them with smokeless South Wales coals. But that is only temporary and with winter looming ahead, we shall presumably suffer once again from the black outpourings which London, and other ports know so well. In my Address last year I mentioned the Atlantic convoys during the last war and how smoke from a ship could be seen on the horizon before ever a ship appeared. After a few ships had been sunk because of this, most ships in convoy and those at sea in general became smoke conscious and special measures were taken. Those precautions should be adopted now by all ships in home waters.

We need more colour, brightness and cheerful surroundings, and not only in Festival years and at exhibitions. J. B. Priestley often talks about this, but he has not mentioned why the towns he justifiably criticizes are so depressing. What is the use of a rosy glow in one spot of one room when the general surroundings are drably grey ? If we get rid of smoke and put our towns in clean air, then, in time, we shall rid them of that aura of gloom and dinginess that has been one of the most unpleasant features of the century between the two Exhibitions.

Let us hope that by the time of whatever Festival may be held in the year 2051

smoke abatement will have become merely an exhibit of historical interest.

However, for the present, and one might say during the lifetime of even the youngest here today, there remains plenty for the Society to do. I should like to feel that within my own lifetime I might hear a future President congratulating some great city, or some whole county—possibly Lancashire—on having declared its final smokeless zone, so that one could drive, or fly, for miles without seeing any smoke. At the same Conference one might perhaps hear the British Railways being praised for having completed their electrification programme, or the National Coal Board for having made its last colliery smokeless.

These are dreams for the future, which show that there is still a big programme of work ahead for this Society. Although it is one of those bodies whose aim is to make possible their own extinction, that time is obviously far distant.

When the evil of air pollution is overcome, public opinion will doubtless be amazed that their forbears were content to live in a country where nearly $2\frac{1}{2}$ million tons of dirt and soot were discharged yearly into the atmosphere, to be inhaled into the lungs, to ruin our architecture and to make greatly increased labour. When a reform has once been accepted, the previous evil always seems incredible to future generations. Imagine the feelings of young people today at the thought that at the beginning of the last century slavery was a profitable trade in this country, that little more than a hundred years ago small children were working in the mines, pulling trucks in the dark, and at a closer date, that their own mothers were denied the right of voting as citizens. All these and many other reforms against which no-one would raise a voice today, took years and years of persistent agitation before they were passed. Many crusaders have devoted their whole lives to a cause which is now undisputed but which would not have been achieved if those few people had not cared deeply and made great sacrifices.

In this retiring Presidential Address, I want to pay a tribute to the loyalty and persistance of the members of this Society. You may think the work cannot be compared with the world's great humanitarian campaigns but it is a cause of high importance.

At this moment in our country's history, the efficient use of coal is perhaps the most important question, and fuel efficiency and smoke abatement are closely associated subjects. Fuel efficiency affects not only the health and happiness of the people, but the future prosperity of the country and even international relationships. It is therefore a matter of first national importance that coal should not be wasted, as it *is* wasted when half of it goes up the chimney in smoke. It has been said in the House of Commons recently that an inefficient fireman who allows his chimney to belch forth black smoke can waste as much coal in one day as a skilled miner can produce.

So I want to conclude by emphasizing the value of this work and by congratulating those who support it by giving so generously of their time and their money. Perhaps I might mention particularly the Local Authority members, who after all have many important causes at heart and who may sometimes think that they would like to see more results from this Society. The fact is that smoke abatement from the very nature of its cause, is a long-term task and despite all it could do towards saving fuel in these days of shortage, it cannot win all the attention it should or be given the priorities we should like. The Society has shown an example of what can be done with very slender resources and with more financial assistance, which would include a bigger staff, it could do very much more.

Personally I am very proud to have been President of the Society during these two years, and I shall follow its work in the future with the closest interest.

POWER AND WASTE IN THEIR SOCIAL SETTING

by

Dr. J. Bronowski

I OUGHT not to begin what I am going to say without first thanking the Society for asking me to give this lecture. No doubt this is a usual beginning ; but I do not therefore make it perfunctorily. I thank the Society for having asked me to give this lecture because it gives me the occasion to speak about something which has been much on my mind. That subject, I will be frank with you, by no means stops at smoke ; indeed you will have noticed that I have adroitly scratched the word "smoke" from my title. My subject has grown in my mind from thoughts which began at smoke. But it has grown to become for me, in the last years, a wider problem and a graver presence. For my subject is the future of this country.

Smoke is a thing which we make for ourselves ; nobody helps us to make it, not even fate. We make it of course by the way we burn our coal, which means by the way we do our work and our living. There are therefore two ways to end the nuisance of smoke. One is to give up this industrial work and life, and turn to something else : something simpler and greener. The other is to hold to our industrial life and to get rid of the smoke as something which has no business there : not a part of industry or even of city life, but a blemish on them.

Living by Industry

I should tell you at once that my sympathy lies wholly with the second of these two cures. I like the country, and I am happy when I or anyone else can work where there are trees up the road and a stream under the hill. But the trees and the stream do not mask the fact that you and I and every man-jack in Britain, fifty million of us, live by industry. When we reach down, our roots strike iron : the baker and the village postman, the tinsmith and the carpenter, the collier and the analyst, and yes, the farmhand too. We are a country built upon a bottom of industry ; and to withdraw from industry is, as a people, to give up our life.

All this is patent, and it would not be worth saying if it were not, for that reason, so easily shrugged out of the argument. We in this hall are all against smoke ; and we are against dirt and rickets and boiler-maker's deafness. I hope that we are against every evil in which industry has a part ; but do not let us therefore be persuaded that we are against industry. There are those who see in smoke only the symbol of industry, and whose attack on one is an attack on the whole basis of our life these last two hundred years. They would like somehow to turn us into a farming country, and to see London all fields again. I must make it clear that I am not of their party and I hope you are not. There are farming countries today and there should be ; but Britain cannot be one. I should not like to see her waste herself. I should like to see London green, but I should not like to see it all fields again. I should not even like to see Sheffield all fields.

The fact is that I am proud of London and Sheffield. They are not handsome cities, and I should like to make them so. But I do not therefore want to plough them up and sow them with clover. Our aim is to make a better thing of industry ; but it is not to destroy it ; not even to belittle it. There have been many blots on industry : child-labour and intolerable hours and dusts and poisons and lock-outs. Some are now wiped clean and some remain : factory dirt, back-to-backs, squalor and decay. We should be ashamed of these, and more, we should make others ashamed. But industry itself is nothing to be ashamed of. I think that industry is the pride and the history of Britain.

An Early Industrial Revolution

Let me make no bones about this at all. When the Elizabethans sailed out into the Atlantic, industry was already the staple they carried and the muscle to their

adventure. Their ships were not paid for with corn but with cloth ; and when they made themselves great with common land, the crop they grew was wool. The gentlemen of Cornwall were not all sailors; some of them were busy in the adventure of mining. The Elizabethan Age was our first industrial revolution, and this deserves better than to be forgotten in the glow from breakfast beer and piracy. London grew rich enough to build the theatre Shakespeare wrote for, not by farming but by trade in her manufactures. These were goods for which the Bristol merchants bargained in the Tolzey and paid on the Nails there.

But I do not need to skirmish with any romantic about the details of Elizabethan coke and glass making. I can step forward a hundred years to another age restless with imagination and movement : the age when John Evelyn persuaded Charles II to give his name to the new Royal Society, much as he persuaded him to look at the work of an unknown carver called Grinling Gibbons. And in the society where Christopher Wren jostled with Newton, and the poet Dryden with Robert Hooke, what were the problems which great men thought worthy of their excited study? They were navigation and metallurgy, gunnery and dye-stuffs, and my own interests which I am proud to trace back to that age—mining and statistics. Newton himself spent thirty years at the Mint, always active and always practical ; and showed by his example how highly his age rated the arts of commerce and of industry.

I want to come still closer to our day. Step forward another hundred years ; we are at 1760 and the Industrial Revolution. It began hard and bleak ; but Blake and Wordsworth were born at that moment, and England doubled her people in seventy years, and put them into leather shoes and clean iron beds and gave them white bread. I am tired of having the Industrial Revolution maligned as if it had put out the sun. Our health and our vigour and the delight in action which is still our pride were made then ; and the men who made them were not money-grubbers, they were great men and I am angry when I hear them slighted. Joseph Priestley and Baskerville and Arkwright, Wedgwood and Watt and their friend John Wilkinson, William Small who taught Jefferson and Count Rumford who hated him—they are the match of any generation that walked the earth with its head high. They built the foundations of the great industries we live by, and I am not in the least ashamed of their work.

Men Make History

You will notice that I have spoken of the growth of industry not in terms of process and turnover, but in terms of men. My reason is that those men were much less muddled than history has been. In the 150 years since Matthew Boulton died, Birmingham has swept round and over the neat factory which he took to Soho because work there was orderly and spacious. Etruria is now as dark as the rest of the Potteries, from whose squalid cottage industry Wedgwood moved deliberately. These men were more clear-sighted than those who came after them. They knew that the things they were trying to do, precision work and glazing china and the fine processes of industry, are not a grimy hugger-mugger and do not thrive in it. To them from the outset dirt and crowding were forms of waste, and they would have liked to scrawl over them as one of them did over other pieces of bad workmanship, "This won't do for Jos. Wedgwood."

They were the pioneers of efficient industry ; but it is not an accident that these Midland men were also liberal humanists, and much suspected of admiring the French Revolution. The fact is that they were single-minded men ; to them waste was waste, whether it was waste of materials or of human skill. They did not draw a line between factory problems and human problems ; and one reason was that they brought to them both a single method—the method of research. They had faith in science, and many of them were remarkable scientists, in the Birmingham Lunar Society and the Manchester Philosophical Society and later in Yorkshire. And it was part of that faith, which Adam Smith underlined in *The Wealth of Nations*, that industry will not do well unless it is run well. When William Murdock put out the torches in the Soho factory and invented gas light for it, when Benjamin Franklin wrote to Boulton that the right thing to do with smoke is to burn it, they did not pause to admire themselves as laurelled benefactors of mankind ; and neither did they think of themselves as gluttons for efficiency. They thought of themselves modestly as scientists, and it seemed to them plain that a sensible solution of a problem of light or heat or output must of itself be efficient and dignified together.

Practical Values are Human Values

I said at the beginning that my subject was the future of industry, and here I have been talking of nothing but its past. But do not be misled ; what I have been talking about is not dead ; for it is the very marrow of every civilization—the belief that its most practical values are also human values. This belief, I insist, was strong in the men who founded our industries. And it was not something which they put on on Sundays. It underlay their thought because their thought was scientific and took all problems in its stride. This is what made them succeed, the assurance that the way to handle a problem is to think right through it, all of a piece ; and we owe our world to it.

That world has not stopped growing since 1760, but in this century it has begun to grow very skew for us. It has been discouraging to see the chemistry of Roebuck and Perkins drift to Germany, the looms go to Japan, the furnaces to Lorraine, and all the steel and metal work of the Midlands go to the United States. We have suffered the fate of all good teachers, that our pupils have turned out very bright. In our plight, we find ourselves advised by two kinds of Jeremiahs. One advises us to go back to the land, and points out owlishly that this would cure the nuisance of smoke by the way. I have already said what I think of this solution, and I will keep my temper and say no more.

The other prophets of despair propose (of course) the opposite. We are now behind in the industrial race, they say, and therefore we cannot afford to do anything but stumble on ; we must not, as it were, stop even to tie our shoe laces. We cannot afford to clean and tidy our works and, what is as important, our processes. We are far too poor, they say, to modernize our plant, or to invest our talent in new research. Let us just sweat along with what stately Edwardian equipment we have ; and when it does at last fall to pieces (though they made it pretty indestructible) why, we can always buy the latest machine from the Germans or the Americans.

Method Not Technique

The essence of this—what shall I call it ? I do not like to dignify it by calling it an argument, and I must call it something. The essence of this nonsense is, that it supposes that what we taught others was simply a technique. Those who speak like this think that our success, in spinning or smelting or making dyes, depended each time on some trick of the trade ; and now others have filched these secrets from us. But this is quite mistaken. What we taught others was method, what we taught them was efficiency and attack, and the techniques are only a by-product of these. Believe me, where the industries of our rivals are ahead of us, it is not because we have taught them to use our techniques, but because we have taught them something more important, to strive for better techniques. We were the pioneers who showed that invention and efficiency will master any problem ; we taught them and, yes, we were willing to learn them too, from Huguenots and French royalist and German liberal refugees. And now that our success has spread to the corners of the world, are we asked to unlearn the lesson ? Are we really going to be content to snort along in an elderly way in the rear of the field, and protest that we have not the time to change our style or our spikes ?

This country has a number of endearing and a number of maddening habits. I count among both a certain strain of Emett and Heath Robinson, which inclines us to treat any elderly piece of equipment much like a pensioned gun-dog whom it would be disgraceful to grudge feed and house-room. I hope that we shall always be able to afford the dog, but I will not hear a word in favour of antediluvian machines ; and least of all do they seem to me lovable because they smoke as fiercely as their owners. The owner may not afford a new machine ; the nation cannot afford the old one.

I am speaking here to the small owner as urgently as to the large—yes, and to the smallest of all, the house owner. For he has a piece of equipment on which he dotes, which is most prodigal of energy and health. I mean, of course, the old-fashioned grate, which as a machine for burning coal was out of date before Benjamin Franklin died in 1790. About that time, William Blake wrote two poems about the child chimney sweeps, which will move me to passion and compassion. Poor climbing boys, their sooty and cancerous trade has not made us much wiser. Our grates still puff out so much benzpyrene that it could give every laboratory white mouse in the country cancer. We still darken the sun with smoke, and then choke the etiolated plants. And we still waste our national income each year, which is as much as

we have recently spent on building new houses.

I am in no doubt at all that this country can hold its place among the leaders of world industry. But not by blowing 16 or 17 cwts. of the energy in every ton of coal up the flue ; and not by scattering sulphur on the wind and begging an allocation in Washington. We talk grandly of harnessing the tides on the Severn at a cost of £100 millions ; but half that sum would modernize enough house and factory grates to save 20 million tons of coal a year. And there would still be quite a margin left for the next generation to save.

John Evelyn fumed against the sulphur in the air 300 years ago, because it withers life. A hundred years later, Roebuck and Keir built our chemical industry on sulphuric acid. Since then the use of sulphuric acid has become as precise a measure of a nation's strength as the figures of horse power or real income. In the last fifty years, world use of the acid has risen sevenfold. What do we do? We complain that we are short of sulphuric acid for our needs, which do not quite reach 2 million tons a year. Yet every year we blow up our chimneys in this country enough sulphur to make at least 7 million tons of acid—four times our own needs, and more than a quarter of the needs of the whole world.

Modernizing Our Industries

For us in this country, and indeed in Europe, the task of modernizing our industries is critical ; and you must let me dwell on it for a few minutes. I have insisted that we are an industrial country. We do not have the resources of North America ; but this does not mean to me that we do not have their industrial potential. It is their agricultural sufficiency which we lack. We can and we must match their industrial strength.

How shall we hope to do this? By looking ahead, and foreseeing now that the materials of industry are changing. They are changing in two ways. First, the treatment is becoming more important than the raw material. We have been using aluminium in aircraft since before the first war. But at that time, the yield point of aluminium alloys was five tons per square inch ; today it is thirty-five tons. The aircraft industry has flourished on technical improvements like this. I can summarize their importance by recalling that the first planes that flew carried 15 lbs. of engine for every horse power they developed. Even before we invented the jet, our native skill in metallurgy and design had cut this down to 1 lb. per horse power. Of course a very British form of sport, called outwitting the Treasury, had already prompted us to do the same thing for the motor car engine years ago.

But there is a second and deeper change in the materials of industry. The familiar raw materials are becoming scarce. Zinc and copper, rubber and wool—once they were indispensable, but now we wonder whether we must long go on paying famine prices for them. Why? We know enough chemistry to build up for ourselves molecules which have almost any property we need. The basic industries must in fact more and more turn to the task of taking these custom-built molecules out of the laboratory and manufacturing them for industry. We are doing this for alloys and already for a great range of polymers, which include fibres and plastics and drugs. But here I think we have not taken a bold enough lead ; for example, we have left the pioneer work in polymers to the oil chemists, and have neglected our own great resource of coal as a basic chemical. Why, if the oil industry had not had the itch for research, it would still be using its product as Rockefeller did—to burn in kerosene lamps.

You will see that the burden of the changes which I foresee is this, that they shift the source of national wealth from raw materials to skill. Very well ; we are strong in industrial skill ; but is not something else also needed to treat and to make the new materials? The answer is yes, indeed ; the new materials will have to be made at a much higher cost in energy than once went into the winning of zinc or rubber.

Energy Sources and Needs

We seem to have reached an odd paradox. We have long been warned of the fearful day when the world resources of energy would run out : oil in tens of years and coal in hundreds. Now I am saying that raw materials are really the scarcer ; and that in any case this country can only live by lavishing its resources of energy on the making of new materials and on their treatment in new light industries. Have then the prophets been wrong in forecasting a famine of energy?

They have certainly been wrong about the world's energy. Our use of coal and even of oil is by no means running away with the earth's stock. Our use of water power is only a few per cent. of that resource, which in Europe alone offers us

75 million horse power ; and this is a renewable resource. And behind these stand a dozen more remote but wholly practical sources of energy, if ever we run short enough to need them. They include the heat of the earth, which has long been used by power engineers in volcanic Tuscany ; and differences of temperature in coastal waters, which are about to be tried in French West Africa. They include wind and tides, the growing of sugar cane for industrial alcohol, and even the flooding of the North African deserts to grow algae in the brackish water. No, the world is not likely to run out of energy, so long as it has man's inventiveness at its command.

But what of the energy needs of Great Britain ? They set us both a harder and a more pressing problem ; and we shall certainly need atomic energy to solve it on the grand scale to which I want our new industries to aspire. I hope that we shall have an experimental power station running on plutonium, as we plan to do, within ten years ; and a massive use of atomic fuels within twenty-five.

But do not therefore suppose that there is nothing for us to do meanwhile, or that our native sources of energy have no part to play. I should not be talking to you this afternoon, and my thoughts would not have begun at the waste in smoke, if I had nothing more urgent to say. We have a great head of energy here, now, waiting to be tapped ; and to make the new industrial revival I have preached, we must learn to use it at once. It is the wealth of energy which we waste, day in and day out. It is the 20 cwts. of energy that is there, ideally, in every ton of coal—and the 17 of these ideal cwts. which we throw away. It is the smoke up the chimney and the soot on the boiler, the steam that goes to waste in the cooling towers and the smell round the gas works, and a million inefficient appliances in every factory and home.

Machines which Think

Let me give you one example, how the new industries of Britain will have to make the most of our resources of power. It is the machine which thinks—at least, it does what its operator calls thinking. That is, it switches itself on and (more important) off, and adjusts itself to its load. This is not a distant fancy—we have begun to use these machines, and we must use them if we are to make the most of our energy and our materials. I will quote what I have written elsewhere, because it puts both the method and the lesson succinctly :

" One means which new factories wil come to use is the automatic contro of their own processes. We find i easier still to have energy leaking from every belt and flywheel than to turn a dozen switches on and off in a sequence of operations. Machines to us are still all thumbs and muscle ; we are not at home with the thinking machine But in fact, the machine which reads its own gauges and throws its own switches is as great a saver of mechanical energy as is the human brain ; and we shall have it with us soon, to stay

There is a moral in this likeness The primitive processes of nature are also lavish in their waste of energy for example, the action of leaf chlorophyll in making sugar from the air, or which all life depends, uses only one per cent. of the sunlight on the leaf But as the living material becomes more highly organized it also becomes more sparing ; until the muscle is a far more efficient user of energy than any machine. The brain does not show so obvious a return of work for the energy put into it as does the muscle Yet the human system has found that i pays to supply each cell in the brain with about three times as much energy as the other body cells. Indeed, the body invests a quarter of all the energy it gets in the brain. The best use o energy is in planning its use."

The lesson is worth recalling when we make plans for the future of our industries

The Energy We Waste

Let me now summarize what I think about this future. In doing so, I hope that you will not grudge me a word o repetition here and there ; for the subject is near my heart, and I do not think exaggerate its importance to us all. think, and I have said, that the largest store of energy which this country possesses is the energy it wastes. Here the cure is modernized plant, the revision o layout and sequences in all industria operations and, above all, new processes And for these, we have a source as ric as the energy we throw away ; the ski of ten generations of men bred to industry It is I think on this that our future rests on the craftsmanship of the fitter and th electrician and the mill-hand ; for cannot believe that any country is poo which has these ready to put to new uses And I do not fear the rivalry of an nation if we give ourselves the chance t match them in invention.

What is the general shape of the industries towards which we should therefore move? Plainly, they should depend more on technical skill than on raw materials. Raw coal and iron were once our staples, but now their day for us is past, as surely as the earlier days of wool. And we should not forget that we ourselves made the Industrial Revolution out of cotton, which we did not grow. So today we must learn the lesson that we taught to the Swiss, and turn to industries which hinge on skill. There are such industries ready for us, just over the horizon: in alloys and aircraft and other light construction, in chemicals and antibiotics, in the range of new materials built atom by atom to do special jobs, and in the use of coal itself as a chemical.

And we have one advantage over the Swiss. We were after all making watches in Clerkenwell on the factory system before they were a nation, two hundred and fifty years ago. We have a longer tradition of these crafts and, above all, we have an unequalled tradition in science. The Royal Society was already respectable when the Clerkenwell clocks were new. Ever since then we have gone on doing superb work in the laboratory: Cavendish and Joseph Black, Priestley and Humphry Davy, Faraday and Clerk Maxwell, J. J. Thomson and Rutherford—the list is endless, and I have not even glanced at the biologists and the doctors and the geologists and how many more.

From Laboratory to Factory

I am naturally prejudiced in the place which I give to our scientific tradition and to the potential of discovery which it carries. But whether you go all the way with me, or only part way, do not neglect this rich source of industrial strength which lies under our hands. In the five years since the war we have won the Nobel prize for physics three times, for chemistry once, and our three discoverers of penicillin have won the prize for medicine. I could add that a British mathematical philosopher has won the prize for literature, and a medical pioneer in nutrition has won the Nobel peace prize. But it is already a record without equal in any five years; and it leaves no doubt that, at the laboratory bench, we have all the genius that we shall need.

Can we translate it from the laboratory to the factory? There, let us confess it, lies our weakness. We are short of the technologists who are expert in making science practical. Indeed, we are not always sure what a technologist is, and we go on thinking that he can be trained in a technical school with men who are learning a much simpler skill in one industry. The step from the glassware on the bench to the full scale plant, the transition through the pilot plant, which is the special province of the technologist, that we have yet to learn. We have to learn it today in one field most of all: the field of atomic energy. J. J. Thomson and Rutherford created that, and more than most nations we shall want to turn ten years from now towards the massive power in a small space which it can yield. We, the discoverers, can command it if we bring to its problems the fundamental science and the skill in technology which together are the brain and the nerves of a modern nation.

I warned you that I should wander from smoke, and I have done so. But in doing this I hope that I have shown you that the problem of smoke fits squarely into the larger problem of our industrial future which should be troubling us. Smoke is a nuisance, and every discovery man makes sets him at the same time a nuisance problem. In twenty years we shall have the nuisance of atomic wastes, and I hope that we shall have sturdy and indignant pioneers to combat them. But smoke is also more than a nuisance; it is a symbol of the untapped resources which we have ready to hand, in the waste of power, of materials, of industrial skill and scientific discovery. I believe that our life as a great nation depends on reaching down into these resources. If we put an end to the waste of them all at once, you and I may think our task well done. And we shall be just in time to turn ourselves into the National Society for the Abatement of Atomic Wastes.

THE SMOKELESS OPERATION OF SMALL STEAM RAISING PLANT

(The Papers in this Session were kindly arranged by the Combustion Engineering Association.)

(I) HAND-FIRED BOILERS

by

V. R. Chadwick, J.P., M.I.MECH.E., F.INST.F.

(Presented by C. E. Newman)

This paper is a modest attempt to indicate the results of practical experiments to obtain smokeless combustion based on a knowledge of the theory of combustion.

Theoretically, 12 lbs. (160 cu. ft.) of air are required for the combustion of 1 lb. of carbon to give 21 per cent. CO_2. In practice we take 18 lbs. (240 cu. ft.) to obtain 14 per cent. CO_2.

The available fuels in this country range from 2 per cent. to 40 per cent. volatile requiring different methods of firing, but the ratio of air to carbon whether fixed or volatile remains the same. An important point to remember when using high volatile fuels, is that two things, and two things only, cause smoke :

(1) Insufficiency of air for complete combustion.

(2) Insufficient temperature to ignite the newly liberated hydrocarbons.

A combination of the two results in very dense smoke, and is rightly punishable.

The rate of combustion follows a definite line, and cannot, in practice, be exceeded. The rate R can be expressed by the formula $R = \frac{K}{F}$

where R = rate of combustion in lbs. per sq. ft. per hour.
F = percentage fixed carbon.
K = a constant for each particular boiler plant.

Thus, with fuel containing 60 per cent. fixed carbon and a maximum burning rate of 30 lbs. per sq. ft. per hour the K would be $R \times F = 30 \times 60 = 1{,}800 = K$. From which the maximum rate with any other fuel burned on the same boiler plant can be calculated.

Low volatile fuels are best burned with a level fire 4 to 6 units deep, i.e., 1 in. nuts, 5 in. deep and 2 in. round coke 8 in. deep, and so on.

Large size high volatile fuels, offer no difficulty to smokeless combustion, due to the fact that the exposed surface, per unit weight of the fuel, is relatively small : the light volatiles are driven off at a comparatively slow rate and there is usually sufficient secondary air present in the furnace to complete combustion of CO to CO_2.

Small size fuel, on the other hand, has a large exposed surface per unit weight of fuel, from which the light volatiles are quickly distilled and liberated, which, in the absence of sufficient secondary air to complete combustion from CO to CO_2, will pass off in the form of smoke.

Taking advantage of this simple principle, various methods of hand firing have been tried with successful results. The oldest, perhaps, is deadplate firing, where fresh fuel is heaped on the deadplate, at the front of the fire, and when the volatiles are driven off the fire is levelled over and a fresh charge thrown on the deadplate. This method is inefficient as there is a tendency to allow the back of the fire to burn too thin, allowing excess air to pass through the fire.

Another method is the side, or wing, firing, in which each side of the fire is fired alternately, leaving the bright half of the fire available to ignite the volatile carbons driven off the newly fired fuel. This method is efficient, providing the fire is not allowed to burn down too low.

Another method which has become popular where very volatile or smoky fuels are used, is known as the hog or whale-back firing (see Fig. 1). Starting

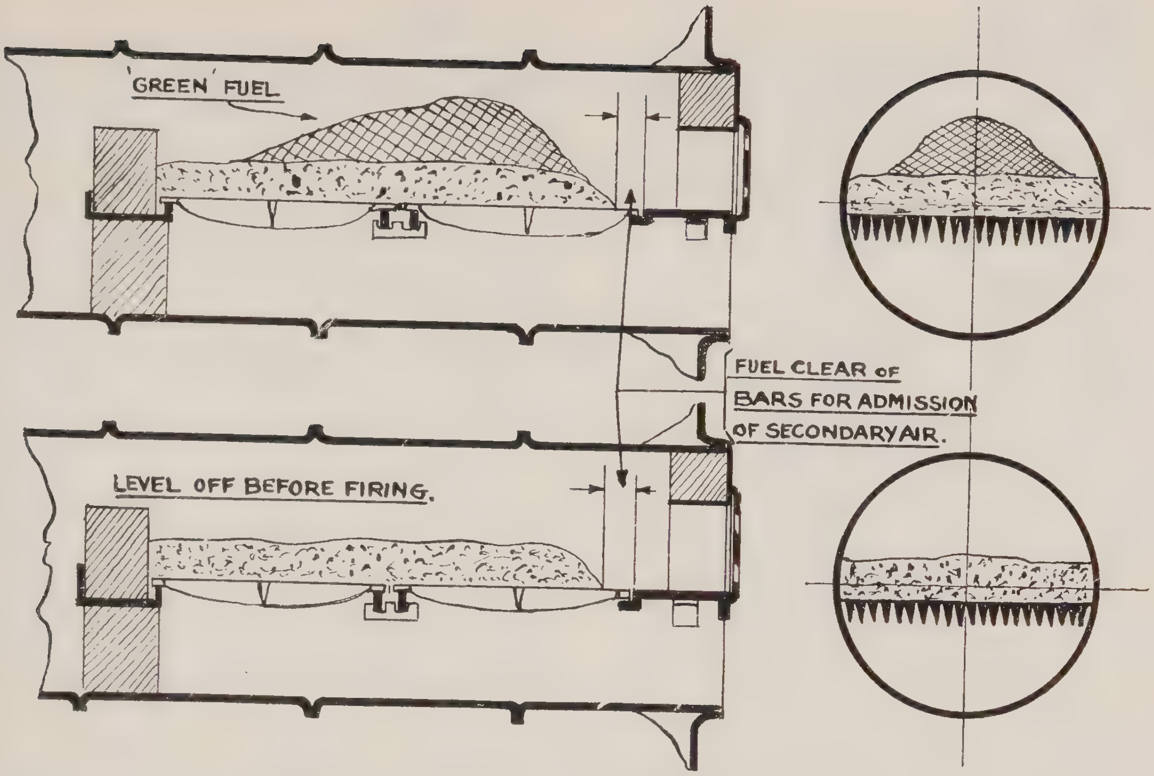


Fig. 1. " Hog " or " Whale back " firing

with a level fire, the fresh fuel is piled in a heap with its peak about one-third of the way along the grate, and allowed to fall down steeply on either side and gradually towards the back. The effect is that as a comparatively small surface is exposed for distillation, there is sufficient incandescent fuel at the sides, front and back, to ignite the volatiles as they are liberated and as combustion proceeds the fuel falls down to the base. When the volatiles are all liberated, the fire is levelled over and the cycle of firing repeated.

On a 30 ft. × 8 ft. Lancashire boiler with a high volatile fuel and using this method of firing, an evaporation of 6,500 lbs. to 7,000 lbs. per hour, and an efficiency of about 65 per cent. with smokeless combustion is being obtained.

Supernumerary to the above, means have been made for introducing the correct proportion of secondary air over the bed of fire into the furnace.

The files of the Patent Office disclose a multiplicity of ideas for smokeless combustion all based on the admission of secondary air, either by natural or forced draught, into the firebox. The methods used are :

Through a flap in the deadplates.

Through or over the firing door.

Through or behind the firebrick bridge.

A special chamber behind the bridge, or combinations of these arrangements.

Some are automatic in action, controlled by the opening of the door for firing, and some can be regulated by hand to suit the class of fuel being used. In any case, preheated secondary air is essential for smoke prevention. Cold air only cools the hydrocarbons and aggravates the evil, and only those systems which employ preheated secondary air, properly controlled, can be used with any assurance of success.

Experience has proved that this proportion should vary with the percentage of volatile carbon in the fuel. In low volatile fuels practically 100 per cent. primary air is needed. With fuel oil (100 per cent. volatile), 100 per cent. secondary is used. Fuels with 35 per cent. volatile carbon should be treated accordingly.

Probably the most common cause of smoke is the practice of putting a large charge of fresh fuel on a slow burning fire and closing the firing door ; the light volatiles are driven off, and in the absence of sufficient secondary air to complete combustion, smoke is formed and passed to the chimney. As this is the most common cause of smoke no excuse is offered for its repetition.

Vertical Boilers

The laws governing the firing of low volatile fuels to shell type boilers apply also to vertical boilers. High volatile fuels give the best results if the fresh fuel is piled in the form of a peak heaped in the centre of the grate, leaving the base composed of a bright incandescent fire.

Cleaning Fires

A very common cause of smoke is the operation of cleaning the fire. This operation can be performed quite smokelessly, if the fires are not allowed to burn down too low ; the incandescent fire from one side pushed over to the other, then the clinker drawn out, and on the newly cleaned bars fresh fuel is charged to a depth of about 2 in. The incandescent fire, from the other side, can then be pushed over on top of the newly charged fuel leaving the ash and clinker free to be removed, after which, another charge, say 2 in. of fresh fuel is thrown on the newly cleaned bars, and the incandescent fire levelled over. The smoke from the fresh fuel having to pass through the incandescent fire, combustion is smokeless and normal firing can be resumed in a few minutes.

This paper would not be complete if mention was not made of the prejudice which still exists, in favour of tightly shutting the firing doors under all conditions, irrespective of the type of fuel being used. It has been fully demonstrated that the same efficiency, i.e., output,* and percentage CO_2 can be obtained from the same boiler when the percentage of secondary air used for combustion varied between 6 per cent. and 26 per cent. and the most smokeless combustion was with the higher percentage of secondary air.

In practical experience the railways burning South Wales coal use very little secondary air, whereas on the northern lines where high volatile fuel is fired, about 30 per cent. of secondary air is used to advantage. It should surely be our object to profit from other people's experience.

FOOTNOTE

* ROBEY & HARLOW.—Heat Liberation and Transmission in Large Steam generation plants. Proceedings Institute of Mechanical Engineers, 1933.

(2) THE CHAIN GRATE STOKER FOR SHELL BOILERS

by

C. H. G. Hayward, A.M.I.MECH.E., M.I.MAR.E., M.INST.F.

In the days when ample coal supplies were available and prices bore some relationship to quality, the method of firing shell type boilers could be decided upon with the assurance of a regular supply of suitable fuel. Under these conditions, it is not surprising that mechanical stokers of any type on shell boilers were regarded by many as a luxury. Even when mechanical stokers were fitted they could be designed with the same assurance of suitable fuel supplies.

The passing of the cheap fuel era, shortage and high cost of labour, allied to the necessity for conserving our national fuel resources, have all emphasized the vital importance of fuel economy in the smaller steam raising plants, which in the aggregate are by far the largest industrial consumers.

A further factor which has had an even greater influence on combustion equipment has been the progressive deterioration in the quality of coal both in ash content and sizing.

Whilst mechanization in the mines will no doubt do much to alleviate the shortage of coal it will also have the inevitable effect of producing much larger quantities of slack and fines, which will have to be utilized, not only in large power plants, but also in the smaller industrial plants which commonly rely on shell boilers of the Lancashire or Economic types for their steam raising requirements. Some indication of the extent of the problem will be realized from the official estimate that approximately 40 million tons of coal are burnt annually on industrial boilers ; whilst the Ministry of Fuel and Power census indicates that about 44 per cent. of all shell boilers are hand fired, and although limited supplies of graded fuel are available, these are urgently required

for export and are being replaced wherever possible by untreated slacks.

At one time there was little difficulty in obtaining men skilled in hand firing this type of boiler, due to the drift ashore of trained men from the Navy or Merchant Marine ; but with the turnover to oil fuel for marine purposes, the supply of this type of man has virtually ceased and although brawn is still available, the necessary brains which used to go with it are frequently lacking for the heavy manual work which is admittedly unattractive. It is, therefore, not surprising that many works are experiencing difficulty in maintaining steam production with equipment which was never intended to deal with such fuel.

The introduction of mechanical firing of steam boilers in Great Britain, followed a Government enquiry of 1820, into the question of smoke prevention ; but it was not until 1880 that much thought was given to the efficiency of steam boiler plant and since then the development of the mechanical stoker and steam boiler has taken place rapidly side by side.

In 1841 a patent was taken out in this country, which embodied the complete invention of the chain grate stoker. Earlier patents had been taken out by other people for various types of stokers but most showed the chain grate as merely an alternative. Without doubt, Mr. John Juckes's Patent No. 9067, dated 1841, identifies him as being the first chain grate stoker enthusiast.

It was not until 1883, that the manufacture of chain grate stokers commenced as a commercial proposition but not many were installed in industrial undertakings until the turn of the century.

Since then, inferior fuels have been burned increasingly on water tube boilers both in power plants and large industrial plants and up to date the chain grate stoker has been widely accepted as being one of the most efficient means of dealing with them. It was therefore logical that such a machine would be developed to deal with a similar problem in shell boilers. Attention was sharply focused on the need for an improved appliance for shell boilers during the war years when boilers of this type in many Royal Ordnance factories were of necessity derated to little over half their rated output due to the inability of existing types of firing equipment to burn these inferior fuels.

The application of the chain grate to shell boilers presents many problems to the designer owing to the restricted space into which it must be introduced. Whereas on a water tube boiler installation the depth of the grate itself is usually about 3 ft. with a large combustion chamber above it and an ashpit beneath it, the chain grate for say a 30 ft. by 9 ft. Lancashire boiler has to fit into a furnace tube of about 3 ft. 6 in. diameter and provide space for combustion as well as for ash removal. Fig. 1, which shows a section of a typical installation of stoker and ash extractor in a Lancashire boiler, illustrates this point.

Briefly, the general principle of the chain grate for shell boilers differs little from the larger types in use on water tube boilers. The grate consists of an endless chain of short links driven from the front

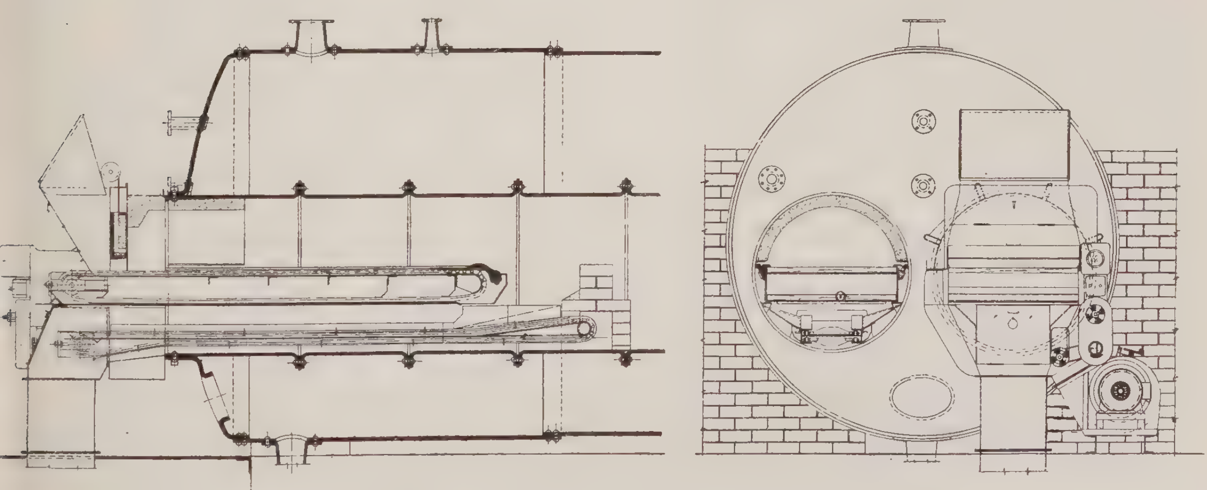


Fig. 1. Arrangement of ash extractor fitted to chain-grate stoker

by an electric motor through a worm reduction gear. The fuel is fed on to the front of the grate from a hopper immediately above it and passes under a guillotine door which regulates the thickness of the fuel bed. The grate speed is varied to suit the steam requirements and the type of fuel in use. Forced draught which is essential in burning poor quality fuels, is supplied by an independent fan fitted to each stoker, the quantity of air being controlled to suit the firing rate. The grate is divided into zones ; the air to each zone being also controllable. Secondary or over fire air is provided, for use when necessary, to eliminate smoke. The ash is discharged automatically over the rear end of the grate into the bottom of the flue tube from which it is removed either by hand or by an ash extractor.

The machine has now established itself over the last eight years as being able to burn efficiently a very wide range of fuels whilst maintaining the rated output from the boiler. The following comparative tests carried out at a rayon works indicates that there was little difference in the performance of the plant when burning a slack containing approximately 35 per cent. below ⅛ in. as compared with D.S. nuts 1 in. by ½ in. which latter fuel was essential to the satisfactory operation of the conventional stoker previously fitted. *See Table* 1.

During the last two or three years the chain grate has been proved capable of dealing with many of the fuels in the South Wales area which possess characteristics which are not commonly met with in English coals. Coke breeze having a size

TABLE 1

Date of test	3.10.45	20.3.46	25.3.46
Duration of test	5 hours	5 hours	2 hours
FUEL :	Griff D.S. Nuts	Griff Nutty Slack	Griff Nutty Slack
Proximate Analysis (as weighed)	Per cent.	Per cent.	Per cent.
Moisture	12.4	13.97	14.57
Volatile matter	30.6	28.41	29.92
Fixed carbon	45.2	40.20	43.30
Ash	11.8	17.42	12.21
	100.0	100.00	100.00
Gross calorific value B.Th.U. per lb.	10,757	9,919	10,440
Nett calorific value (as weighed) B.Th.U. per Lb.	10.105	9,449	9,940
Fuel fired per hour. lb.	1,232	1,440	1.900
Fuel fired per hour per sq. ft. grate area. Lb.	30.8	36	47.5
ASHES AND CLINKER			
Collected per hour. Lb.	110.4	177.6	199.5
Percentage of fuel fired	8.96	12.4	10.8
Percentage of combustible in ash	6.32	10.3	11.7
WATER			
Temperature entering boiler. °F.	255	257	257
Evaporation per hour. Lb.	9,144	9,766	12.630
Evaporation per lb. of fuel. (as weighed). Lb.	7.42	6.78	6.65
STEAM			
Gauge pressure. Lb. per sq. in.	99	98.5	95.5
FLUE GASES			
Temperature leaving boiler. °F.	861	812	918
CO2 leaving boiler. Per cent.	11.6	10.7	10.8
DRAUGHT			
Suction over fires. ″ w.g.	0	0	0
Suction leaving boiler. ″ w.g.	0.54	0.52	0.61
AIR			
Pressure to grate ″ w.g.	0.77	1.59	2.92
Temperature to furnace. °F.	80	68.6	72.44
OVERALL THERMAL EFFICIENCY	Per cent.	Per cent.	Per cent.
On gross calorific value of fuel	66.7	64.33	61.67
HEAT ACCOUNT	Per cent.	Per cent.	Per cent.
Calculated on the nett calorific value of the fuel			
Overall thermal efficiency (boiler only)	71.00	67.63	64.77
Loss due to sensible heat in chimney gases	23.65	26.28	29.88
Loss due to combustible in ash	0.81	1.96	1.84
Balance, radiation and unaccounted	4.54	4.13	3.51
	100.00	100.00	100.00

range of $\frac{3}{8}$ in. to 0 is also being regularly burned, particularly in gas works where the utilization of an otherwise unsaleable product has resulted in considerable financial saving in addition to increased steam output from the plant and the release of a saleable product for other purposes. One of the difficulties encountered in burning breeze is that of ensuring ignition, due to its low reactivity. A patented recirculation system has been developed by which means hot gases are drawn over the incoming fuel thus raising its temperature and maintaining ignition within an inch or so of the firedoor.

The problem of smoke abatement, with which this society is so deeply concerned, has been with us for a very long time as John Evelyn referred in his "Fumifugium" of 1661 to "that Hellish and Dismall Cloud of Sea Coale" . . . "which is so universally mixed with the otherwise wholesome and excellent Aer," and his Editor in 1772 indicated that the nuisance had increased. As coal was not extensively used for steam raising in those days it may be assumed that a large proportion of it was used in open fires for direct heating and even today the greatest proportion of smoke nuisance emanates from household grates whose design in many cases have not improved since Evelyn's day. The industrial chimney is, however, much more obvious and many local authorities are incorporating in their bye-laws, clauses governing the emission of smoke.

It must be admitted that in designing the chain grate stoker rather more consideration was given to the burning of low grade fuel than smoke abatement and we were very gratified to note on the prototypes that, in addition to solving the fuel problem, smoke was completely eliminated. The chain grate stoker has now gained a reputation for smokeless combustion even with the inferior fuels being supplied today, and smoke abatement officers have shown considerable interest in the machine from this point of view. The reason for the absence of smoke was very well summed up in the following extract from *The Scotsman*, published over 100 years ago and referring to the Juckes stoker :

> "The principle of smoke consumption consists in the slow and regular admission of the coal. Instead of being heaved in with a shovel, so as to produce continual gusts of smoke, it is admitted, as it were, by hairs' breadths. The ignition is, therefore, little at a time, and what smoke is raised having to go over the whole bright fire beyond, it is necessarily consumed. Nothing gets up the chimney but a slight fume, scarcely perceptible to the eye. The apparatus, we are told, has the further advantage of economizing fuel and attendance, while it sustains the steam equally with the common practice of firing. The great beauty of the whole thing, however, is that the smoke is consumed."

It is significant to note that in those far off days of cheap coal, fuel efficiency was considered secondary to smoke abatement.

In many of the smaller industrial plants, the boilerhouse has hitherto been regarded as the necessary nuisance and whilst cheap fuel was available little attention was paid to its economical use. The present high costs has certainly brought fuel economy into the foreground and even though the present price structure of coal is in need of drastic revision, a considerable saving can be effected by installing modern chain grate stokers. In a case recently investigated, a works supplied with steam by one 30 ft. by 8 ft. Lancashire boiler was being hand fired with D.S. nuts, the boiler and firing equipment being 25 years old. Fuel consumption was 15 tons per week at £3 per ton or £45 per week. A suitable fuel for use on chain grate stokers was offered at £2 per ton having a heating value of approximately 20 per cent. less than the original fuel ; but against this there was a saving of 10 per cent. in fuel consumption due to the improved method of firing. Taking these facts into account the nett fuel consumption was estimated at 16½ tons per week at a total cost of £33, showing a saving of £12 per week. In this instance only one lightly loaded boiler was involved and consequently there was no saving in labour.

Labour-saving on a larger installation is well illustrated in the case of a plant steaming continuously where fifteen hand fired Lancashire boilers were under consideration. Nine of these boilers have been fitted with chain grate stokers on the basis of eight steaming and one stand by. The improvement in boiler output results in two hand fired boilers becoming redundant, thus leaving thirteen boilers of which five are still hand fired for the time being. Manshifts per week are reduced from 298 to 167, a saving of 131 manshifts. Allowing for overtime rates at weekends the nett weekly saving

amounts to £130. The saving in labour alone in this case means that the cost of the stokers can be recovered in two years.

Attainment of a high thermal efficiency throughout the operating period of the boiler is no longer a matter of sustained toil with heavy firing tools. These results are now achieved by a simple adjustment of grate speed or air control to meet the required load. Brains can now replace brawn with obvious advantages both to the operation of the equipment and its maintenance in first class condition. Experience in training classes leads to the conclusion that a large number of the type of men willing to hand fire a boiler are unable to absorb even the rudiments of fuel efficiency. It is suggested that the employment of the more intelligent type of personnel, even at a higher salary, would more than justify the cost in the fuel saving made possible by the efficient operation of this modern firing equipment. One of the principal avoidable losses on a boiler is that due to excess air as indicated by the CO_2 content of the flue gases. A reasonable day to day CO_2 to be expected with a chain grate stoker would be approximately 12.0 per cent. Unsatisfactory operation could easily reduce this to 10.0 per cent. which represents an increase in coal consumption of the order of 5 per cent. Taking the single installation referred to earlier with a weekly coal bill of £33 this means an increased cost of over £1 10s. per week.

Even an intelligent fireman cannot be expected to realize the full potentialities of up-to-date equipment unless he is given all the tools for the job. By this is meant the provision of a few simple and reliable instruments which will ensure that the best conditions are being maintained at all times. There still appears to be some reluctance on the part of many shell boiler users to install instruments of any kind other than the statutory pressure gauge and water gauge, and even when instruments are installed, they frequently receive no further attention than that given during the initial installation, with the result that they become inaccurate and fall into disuse. Most instrument makers of repute are now prepared to provide periodical service visits for a very reasonable figure.

(3) COKING AND SPRINKLER STOKERS

by

H. E. Pearsall, A.M.I.MECH.E., F.INST.F.

In the year 687 a certain monk of the Monastery of Glastonbury unearthed what he described as "a quantity of blacke stonne." His Prior, considering the Monk's discovery of little interest consigned the "black stonne" to the log fire, where, to his profound astonishment it began to burn and give off heat.

It is, therefore, surprising that it was not until the end of the 13th century that coal was used in London, and even at that time, the smoke emitted was regarded as injurious to the health of the people. Indeed, it is recorded that in the year 1307 a man was beheaded in London for burning coal, and two and a half centuries later, "Good Queen Bess" considered the burning of coal such a nuisance that she forbade its use during the sitting of Parliament.

Today, in Great Britain, more than 50 million tons of coal are burned each year on shell type boilers.

The advent of the mechanical stoker heralded an effort to reduce the emission of smoke, and although it is difficult to assess claims regarding the invention of the earliest type of apparatus for this purpose, credit is usually given to a Frenchman named Delasme, who exhibited a non-mechanical apparatus at St. Germain in 1685.

A century later in 1785, the famous British engineer, James Watt was successful in obtaining letters patent concerning "a furnace in which smoke production was eliminated."

Watt's machine, despite the crudeness of its conception, embodied certain principles which have since formed a fundamental basis in the development of mechanical firing.

The changing pattern from the crude and clumsy mechanism of 1785 to the efficient machine of the present-day is in itself a tribute to the inherent skill and

creative genius of those who take their place in history as pioneers in the development of the mechanical stoker. When it is realized that few special purpose machines are called upon to meet such exacting conditions in service the merit of this tribute is beyond question.

Outstanding amongst the many who contributed to this period of development were William Brunton, John Bodmer, John Stanley and John Juckes. These men recognized that the various constituents of coal required independent treatment, and the importance of devising suitable equipment to provide the conditions under which this treatment could be properly applied.

Under the selective processes of design and application the coking and sprinkler type of mechanical stokers have emerged.

Coking Stoker (*See Fig.* 1)

In this type, the coal is fed from a hopper to a reciprocating ram which deposits a small charge of coal on a coking plate at the front of the grate. Here the volatile matter begins to distil and the fuel becomes incandescent and passes gradually on to the main body of the grate. This is comprised of a number of moving bars, operated by cams which are so designed that all the bars are moved into the furnace together, carrying with them the entire firebed. Alternate bars return in two pre-determined cycles without disturbing the position of the firebed and each sequence of this method allows the forward movement of the firebed of about three inches. Thus travelling the complete length of the grate combustion of the fuel is completed and the residue is discharged into an ash chamber from which it is manually removed as and when necessary.

Suitable fuels are bituminous coals with slight or medium caking characteristics. Singles and Peas are ideal, but 1″ or ½″ rough slacks are satisfactory.

Sprinkler Stoker (Shovel type) (*See Fig.* 2)

Coal is fed from a hopper to a reciprocating ram which deposits a small charge into position in a lower shovel chamber, where a spring loaded shovel transmits the charge of fuel over a predetermined section of the firebed. The spring load to the shovel is usually governed by a rotating tappet mechanism which transmits the load by engaging with a trigger mounted on the shovel shaft. The tappets are designed to be adjustable to vary the trigger release in such a way that different sections of the firebed are covered by each discharge and complete and even coverage of the grate area is then obtained.

This type of feed mechanism may be used with either the moving bar grate as common to the coking type, or alternatively with a stationary design of grate in which case ash is removed manually from the surface of the grate.

Sprinkler Stoker (Paddle type) (*See Fig.* 3)

In this type the shovel is replaced by a rapidly revolving rotor or paddle which spreads the coal over a grate usually of the stationary type.

Both types of sprinkler stoker will handle a wide range of coals, free burning, or with slight, medium or strongly caking characteristics. Singles, Peas or 1″ rough slack are eminently suitable, but coals ranging between an upper size limit of 2″ and a lower limit of 25 per cent. though ⅛″ sieve are satisfactory.

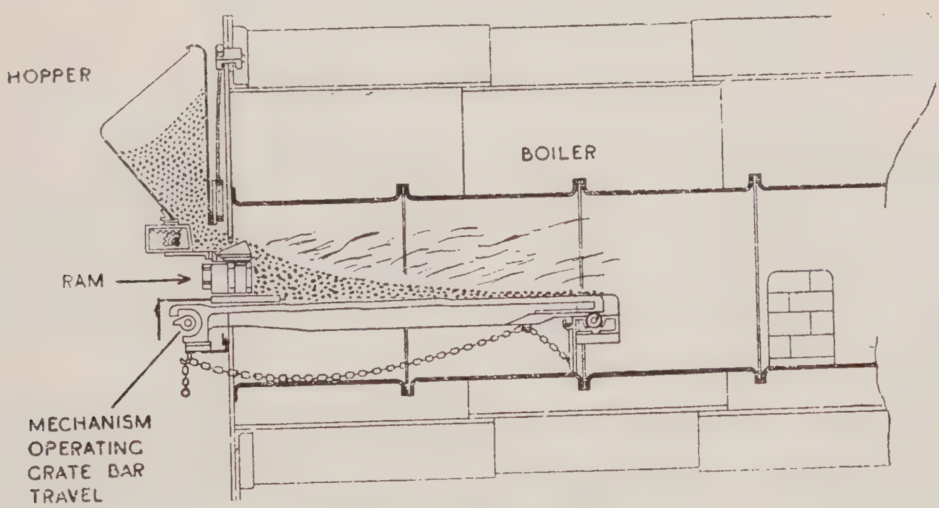


Fig. 1. Coking Stoker

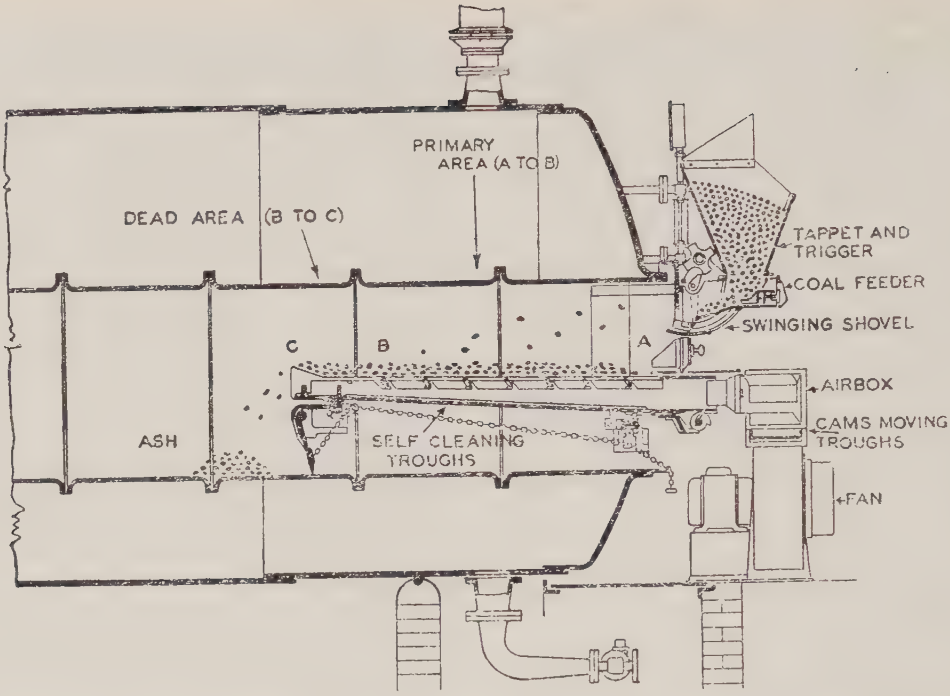


Fig. 2. Moving Grate Sprinkler Stoker, Shovel Charging

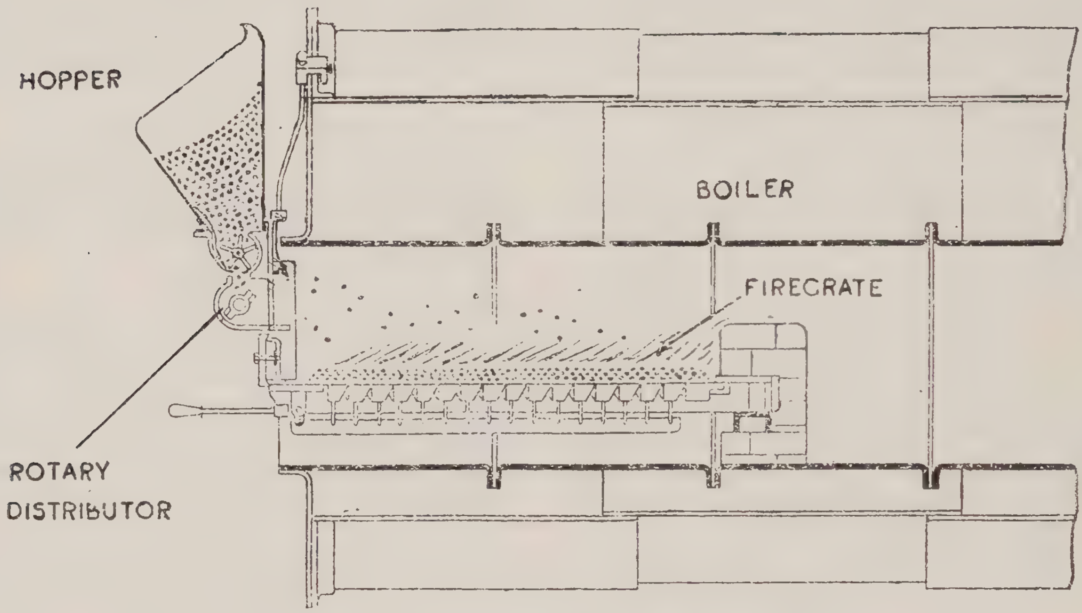


Fig. 3. Rotary Sprinkler Stoker

The types of stokers described will
(1) Deliver the fuel to the grate automatically.
(2) Handle a very wide range of fuels.
(3) Give freedom from smoke emission.
(4) Enable a high rate of combustion to be maintained.
(5) Produce a high combustion efficiency.
(6) Keep maintenance costs relatively low.
(7) Provide freedom from mechanical breakdown.

To have achieved this is to have achieved much which from time to time has been regarded as impossible, but the demand for efficiency and economy is greater than ever, stimulating the flow of new ideas, and opening the door to further advancement.

Smoke Emission

At this conference the emphasis is naturally on smoke abatement, and a mere restatement of the claim that the mechanical stoker gives freedom from smoke

emission is not enough. It is, therefore, fortunate that definite evidence is available and not difficult to present.

Efficient combustion depends upon supplying the correct amount of air for the amount of fuel being consumed. Too much fuel or insufficient air cause "indigestion" in the fuel bed and a considerable part of the fuel escapes in a partially burned condition usually producing a heavy smoke emission from the chimney.

A Lancashire boiler 30 ft. long by 9ft. diameter will probably use 1,200 lb. of coal per hour, that is 10 lb. of coal per grate per minute. If we, therefore, base on a good fireman, charging his boiler every five minutes (an interval of ten minutes each flue) he will charge each grate with 100 lb. of fuel which will take ten minutes to burn. One third of the fuel will be released as volatile matter during the first minute or so, and it is almost impossible within this short period, to provide the extra air necessary to produce efficient combustion, the result being black smoke and excessive heat loss.

In the case of mechanical stoking much more frequent charges of small quantities of fuel are achieved.

Each ram of a coking stoker makes 3½ feeding strokes per minute, a little less than 3 lb. of coal being fed at each stroke, the volatile gases released travelling over the entire length of the incandescent fuel bed and consequently being fully consumed.

In the case of the sprinkler stoker, the shovel will deliver fuel to the grate at a rate of 12 charges per minute, each charge being less than 1 lb. of fuel.

This constant supply of fuel in small quantities, permits a constant supply of air, resulting in complete combustion and freedom from smoke emission and excessive heat loss.

Excess Air

Although the foregoing evidence would normally be sufficient to justify the use of a mechanical stoker, further advantages accrue from this method of mechanical firing.

In hand-fired boiler, the better the fireman, the more frequently he fires the boiler. The firedoor must be opened to admit each charge of fuel and each opening of the firedoor means an increase in the amount of air admitted—a corresponding reduction in boiler efficiency and a consequent increase in fuel consumption.

The mechanical stoker can do what the best of firemen cannot do: put fuel on the grate without opening the firedoors, and constantly maintain a level even fuel bed.

Graphs 1 and 2 have been prepared to illustrate the results obtained from tests carefully carried out by the R/16 Committee to determine the relative CO_2 figures from hand firing and mechanical firing methods.

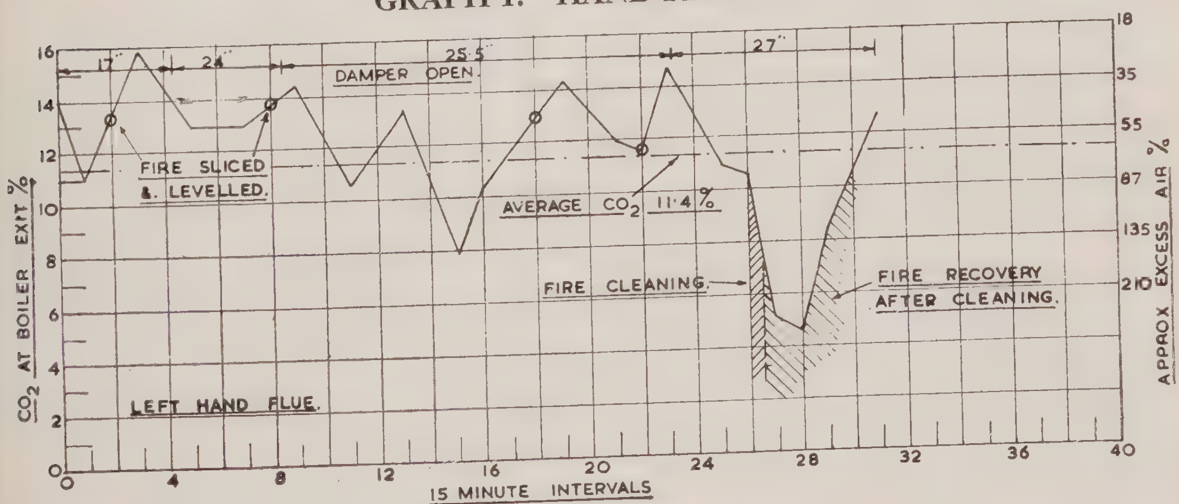
Graph 1 shows the CO_2 obtained by efficient hand firing over a period of 7½ hours.

Graph 2 shows the CO_2 reading over a period of six hours when mechanically firing.

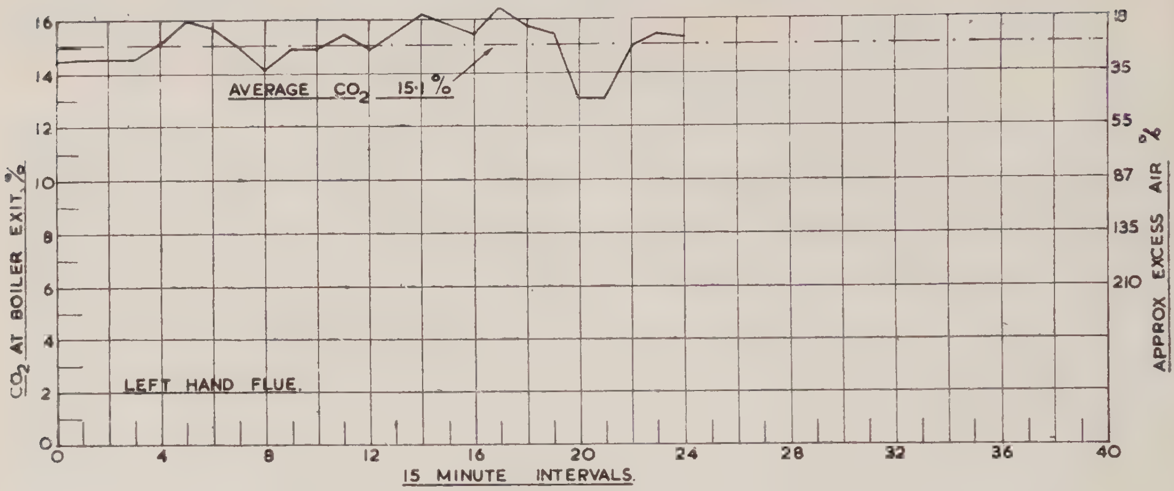
The investigations of the R/16 Committee provided evidence that for each 10 per cent. increase in excess air the consequent reduction in efficiency is:

(1) Lancashire boiler without economiser—2 per cent.

GRAPH 1. HAND FIRING



GRAPH 2. MECHANICAL FIRING



(2) Lancashire boiler with economiser—1.5 per cent.

(3) Economic boiler—0.7 per cent.

The efficiencies in each case with various percentages of CO_2 are shown in Table 1.

Table 2 shows the relative increase in fuel consumption with increasing excess air.

If we compare the mechanically fired boiler without an economiser with one of the very many inefficiently hand-fired boilers, a difference in fuel consumption of 40 per cent. is apparent. This will be the case when the mechanically fired boiler is operating at 68 per cent. efficiency, maintaining an average CO_2 of 14 per cent. and using 1,500 tons of coal per annum. The same boiler when hand-fired with an average CO_2 of 8 per cent. (a not infrequent figure) would only be operating at 48 per cent. efficiency and would consume 2,125 tons of coal per annum, an increase of 625 tons or 42 per cent.

It may be claimed that 14 per cent. CO_2 is somewhat high for the average operative to maintain but there are thousands of mechanically fired plants operating at

TABLE 1

TABLE SHOWING HOW BOILER EFFICIENCY IS AFFECTED BY EXCESS AIR

% Excess Air	25	35	55	87	135
% CO_2	15	14	12	10	8
Lancashire Boiler without Economiser	70	68	64	57½	48
Lancashire Boiler with Economiser	78½	77	74	69	62
Economic Boiler	77½	77	75½	73	70

TABLE 2

TABLE SHOWING THE INCREASE IN FUEL CONSUMPTION WITH INCREASING EXCESS AIR

% Excess Air	25	35	55	87	135
% CO_2	15	14	12	10	8
Lancashire Boiler without Economiser	100	103	109	122	146
Lancashire Boiler with Economiser	100	102	106	114	127
Economic Boiler	100	101	103	106	111

12 per cent. CO_2 and many thousands of hand fired plants operating at 8 per cent. CO_2 or below.

Basing on these figures if the mechanically fired boiler used 1,600 tons of coal per annum the same boiler, hand-fired, would consume 2,130 tons, a difference of 530 tons or an increase of nearly 33 per cent.

The human stoker is always subject to the normal condition of fatigue as the working day progresses, resulting in an impaired efficiency with a direct effect on the quality of his work.

With adequate maintenance the mechanical stoker will work constantly at a predetermined rate.

Smokeless Cities

The Manufacturers of mechanical stokers are proud of their past and present achievements in the effort to eliminate smoke nuisance and are always anxious to co-operate with the various local authorities concerned to this end. From many years of experience they have derived a wide knowledge of the problems concerned when burning almost every type of fuel.

It is their belief that the requests which are sometimes made that so called "smokeless" fuels should be used are a retrograde step. These requests ignore the availability of a proper solution and in addition tend to put an industrial user to a disadvantage by unnecessarily increasing his production costs.

The stoker makers are convinced that the true answer to the problem lies in their ability to provide plant capable of burning bituminous coals smokelessly.

Local authorities and stoker makers' policy is actuated by the same desire—a desire to free our towns and cities from the curse of smoke.

We have the desire, with goodwill and co-operation, we can go forward together to success.

(4) UNDERFEED STOKERS

by

C. C. Day, M.A., A.M.I.MECH.E.

The Underfeed Stoker is now so widely used that a general description may seem unnecessary, but it is the basic principle on which the underfeed stoker operates which enables it to burn bituminous coal without smoke, therefore some reference to basic design is required.

This paper deals with a range of stokers with coal feeding capacities roughly from 12 to 1,200 lbs. of coal per hour.

As its name implies, the underfeed stoker feeds the fresh coal from underneath the firebed and not on to the top as is the case with hand firing. For burning bituminous coals which contain a very considerable quantity of volatile matter the advantage of this system appears obvious.

The fresh coal as it is pushed up into the firebed becomes heated, and the volatile matter is distilled off. The gases and tarry matter then pass up into the incandescent portion of the firebed—or combustion zone—where they are properly ignited and burnt.

In this combustion zone we also have the coke which has been passed up and is here burnt along with the freed gases. The burnt out coke is finally deposited as ash or clinker at the outer periphery of the grate area.

Very roughly we could state that there are four zones or layers in the firebed of an underfeed stoker. Commencing from the bottom these are :

(1) Green coal.
(2) Coal pre-heating zone.
(3) Gas liberation or distillation zone.
(4) Combustion zone.

The advantage of this system is that it promotes complete combustion and freedom from smoke. Under normal conditions its fuel bed presents continuously an incandescent area to the boiler heating surface. The surface of the fire is not periodically chilled by fresh supplies of raw fuel.

The mechanical stoker does what the best fireman cannot do—it puts fuel in the grate without opening the firing door. (*See Fig*. 1).

The principal components of the stoker are :

Retort. The coal is burnt in a retort

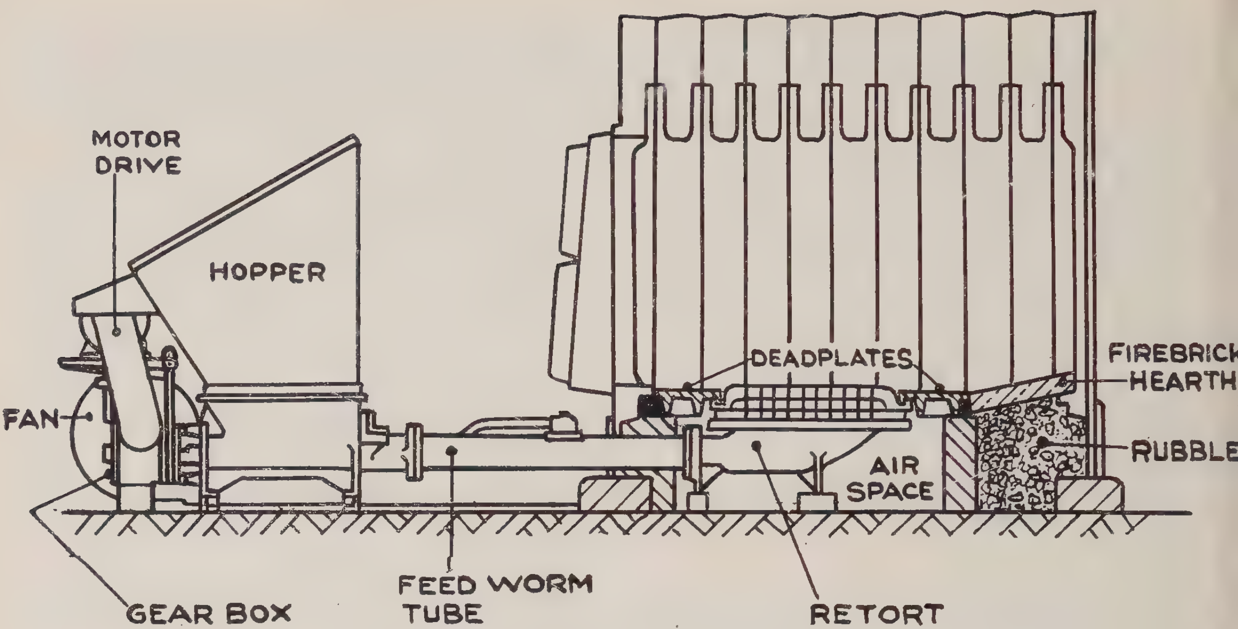


Fig. 1

entering from underneath. The combustion air is admitted to the fire by means of ports in the upper portion of the retort. These are usually arranged in separate segments known as tuyeres and are separately replaceable.

In some installations two part or multi retorts are used to increase the effective width. In others again the retort is supplemented by fire bars or liveplates for the same purpose.

Surrounding the retort is a hearth, which may be either of firebrick or may be composed of cast iron plates air cooled on the underside.

Fuel Transmission. The fuel feed mechanism may be either :

(*a*) *Screw Type.* An alloy steel worm which conveys the fuel along a tube or trough.

(*b*) *Ram Feed.* In this case the fuel is transferred from the hopper to the retort by means of rams.

Air Supply. Combustion air is supplied from a multi-blade centrifugal fan, the quantity delivered being controlled by a damper either on the delivery or the suction side of the fan. This damper can be either manually set or in some cases is automatically controlled.

Drive. Usually underfeed stokers are electrically driven, though in some cases small turbines are used. Generally the one electric motor drives both the coal feed mechanism and the fan.

The feed mechanism is normally arranged to provide several rates of fuel feed.

Varieties of Underfeed Stokers

(*a*) Standard hopper model.

(*b*) Flue model.

(*c*) Bunker to boiler model.

The " Flue " model is a variety specially adapted to fire horizontal shell type boilers viz., Lancashire, Cornish and Economic. Here special consideration is given in the design to meet such factors as for example the comparatively small diameter of the flue, which means that the combustion height is small. Facilities for inspection of the flue are required for insurance purposes, etc. (*See Fig.* 2).

The " Bunker to Boiler " or Bunker Feed type is an important development of the underfeed stoker. Here the stoker draws its coal direct from the coal bunker.

This type has a number of advantages :

(1) Eliminates the filling of a hopper. The coal is tipped by waggon into the bunker and transferred from there by the stoker and fed to the fire.

(2) Gives a cleaner boiler house and stoker, as fuel is not handled in the boiler house.

(3) Stoker mechanism more accessible, due to the elimination of the hopper.

(4) Easier access to the boiler for clinker removal.

(5) Another advantage is that the coal-feed tubes and air ducts can be frequently run under floor level, thus leaving the boiler fronts and the boiler house floor completely unobstructed.

In some cases varieties (*b*) and (*c*) are combined. (*See Fig.* 3).

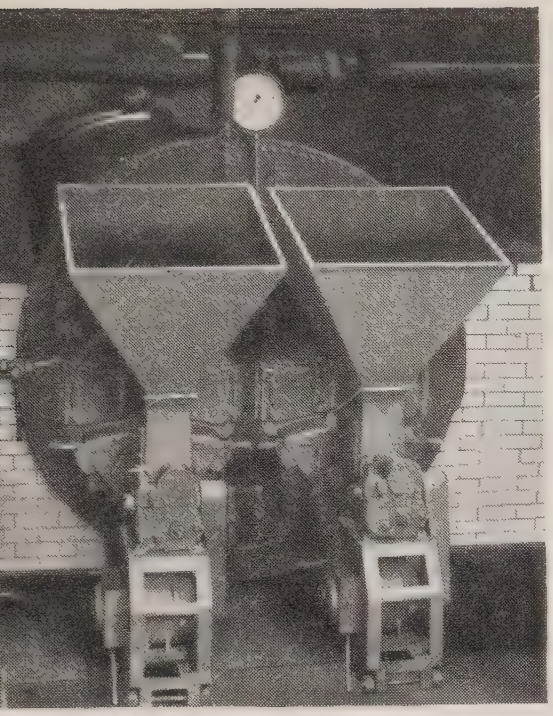


Fig. 2

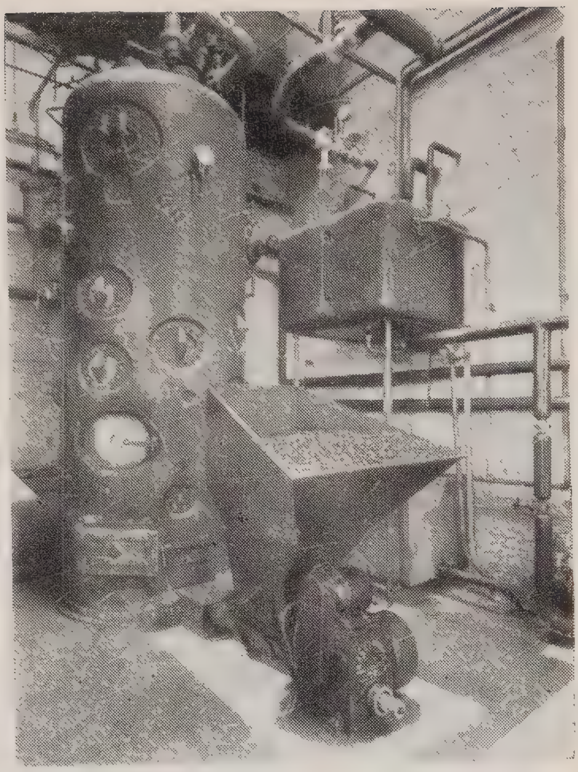


Fig. 4

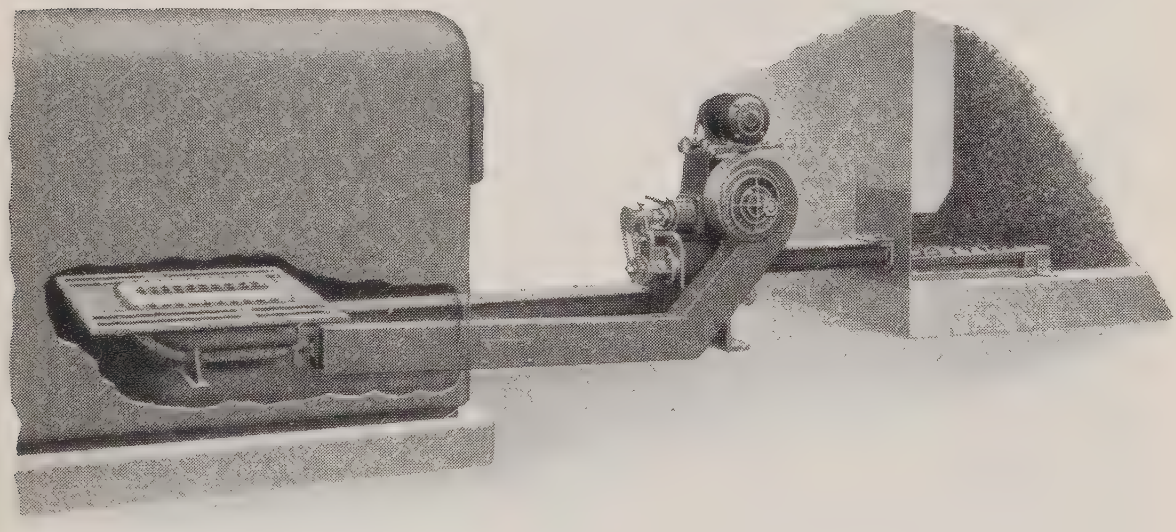


Fig. 3

Application

Boilers. Underfeed stokers are very largely used for hot water boilers, in fact they are the type most generally adopted for this class of boiler.

They are also very widely used for vertical steam boilers of all types, and for loco type boilers.

In the case of horizontal Shell type boilers, namely Lancashire, Cornish and Economic boilers, they do not appear to have been as widely adopted as some other types of mechanical stokers, partly perhaps a matter of price, but in the opinion of the writer, when the necessity to reduce the emission of smoke is more generally realized, then the advantages of the underfeed stoker for this type of boiler will become more widely appreciated.

Underfeed stokers are also frequently used for the smallest sizes of water-tube boilers. (*See Fig*. 4).

Mr. Sydney D. Scorer in an Article in *The Steam Engineer* in 1946 stated that :

> " Some 72 per cent. of all the coal used in English industrial steam plant is burnt in boilers having evaporative capacity of 10,000 lbs. per hour or less."

That is within the scope of the normal range of the underfeed stokers described so that their field of application for boiler firing is a very wide one. (*See Fig*. 5).

Other Applications

There has in the past been some tendency to regard many industrial processes as outside the sphere of smoke abatement practicability, nevertheless, it can be stated with confidence that the underfeed stoker can be successfully applied to very many processes which involve the burning of coal, and the smoke nuisance in consequence eliminated or much reduced.

Underfeed stokers are extensively used for a wide range of application including :

Furnaces of all types ; galvanizing baths ; kilns for bricks, tiles, pipes, sanitary ware, etc. ; drying ovens ; foundry stoves for drying moulds and cores ; grass driers ; air heaters ; vitreous enamelling furnaces ; stills, etc. (*See Figs*. 6 *and* 7).

Controls

To take full advantage of a mechanical stoker it is necessary to use some automatic controlling devices.

In the case of steam raising boilers it is normal practice to fit a pressurestat, which controls the stoker—usually by

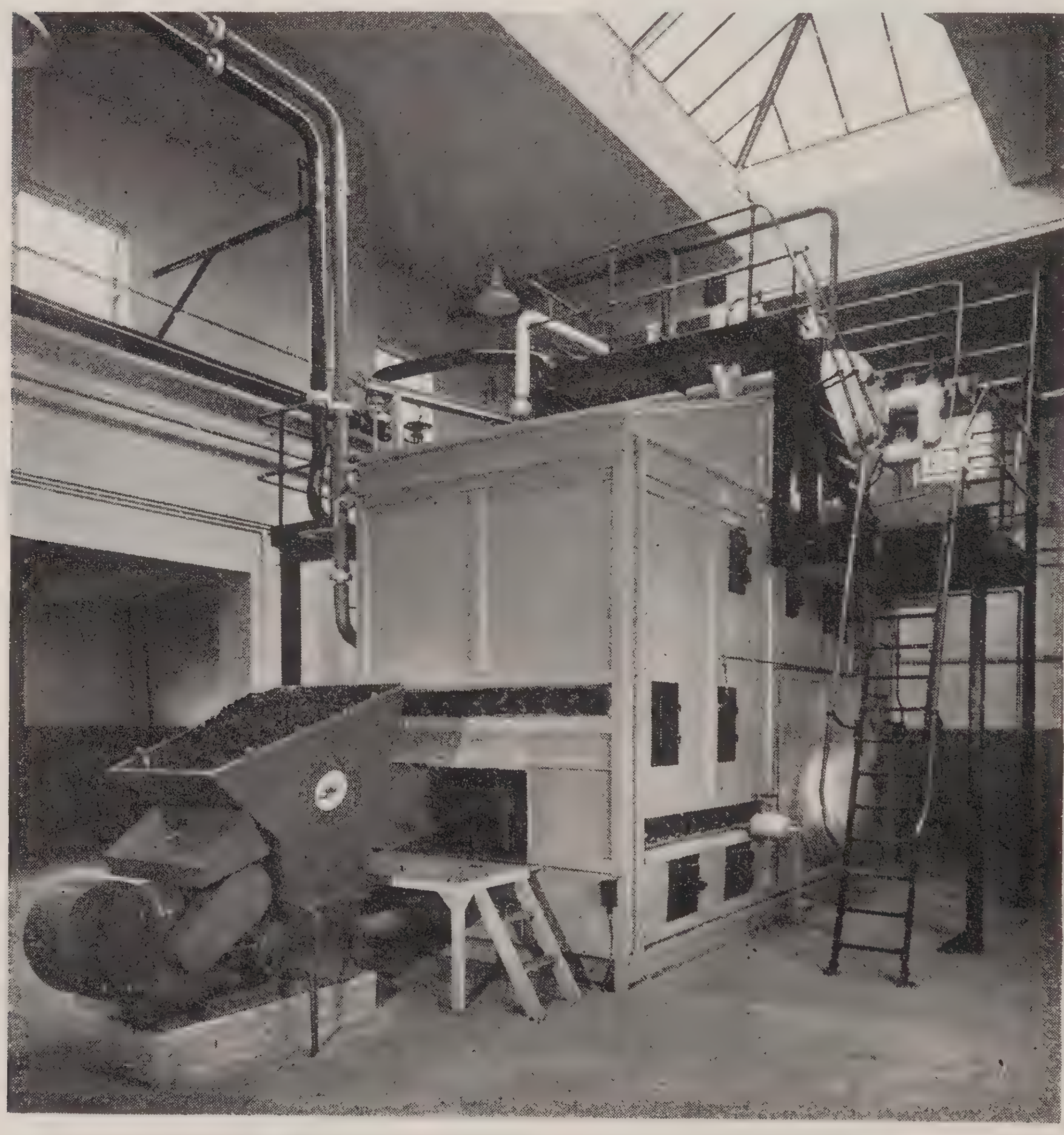


Fig. 5

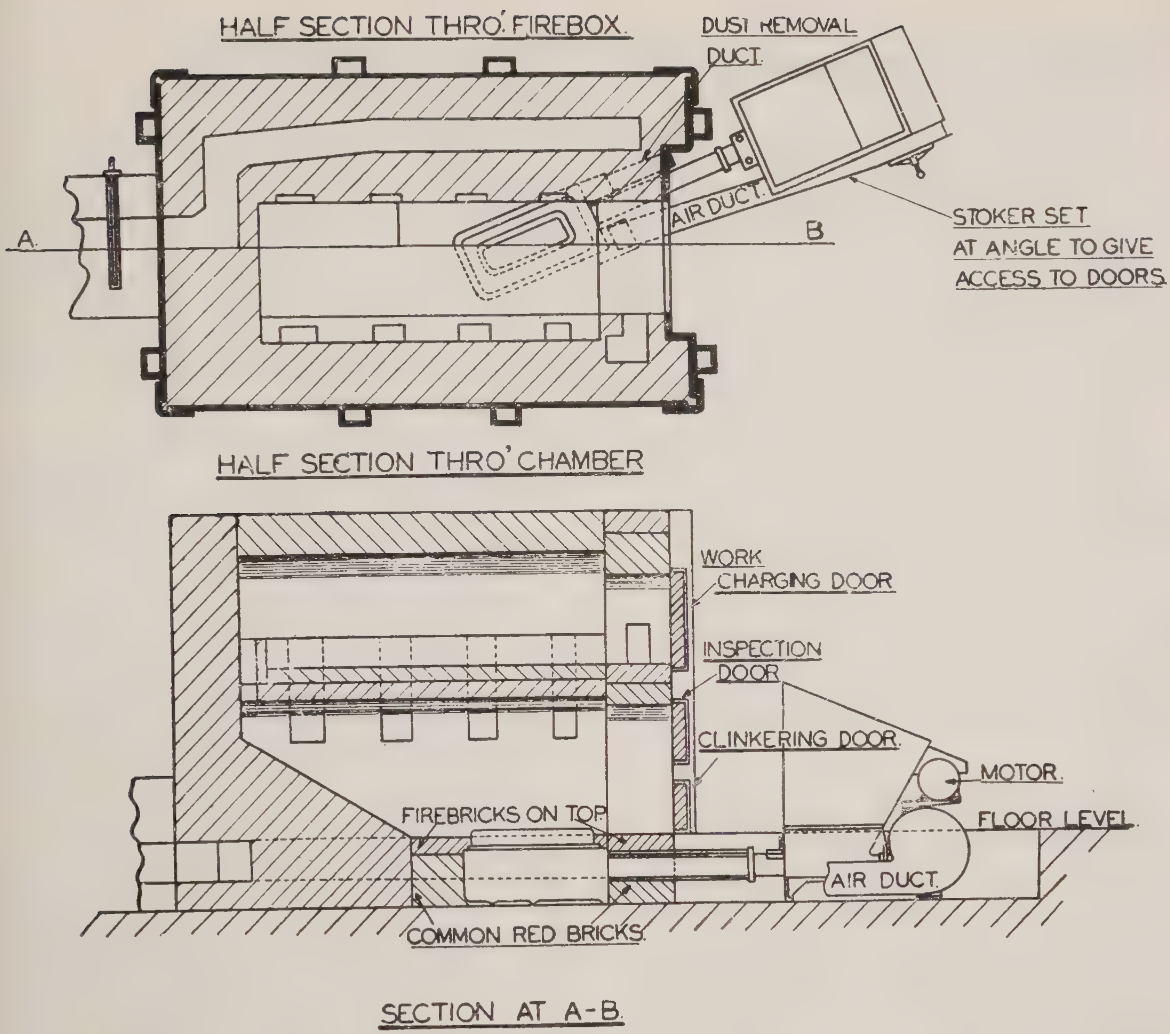


Fig. 6 (top) and 7

stopping and starting the motor—to maintain a steady pressure in the boiler. In some cases the heat output is controlled by automatically adjusting the rate of feed.

In addition a low water cut-out switch should be fitted to stop the stoker in the event of the water level in the boiler falling too low for any reason. In conjunction with this, an alarm bell can be arranged to attract the attention of the operator.

Stokers firing hot water boilers are usually controlled by means of thermostats, to maintain either a pre-determined temperature in the water, or in the case of a space heating system it may be arranged by means of a " room thermostat " to maintain a desired temperature in a typical portion of the building.

The most up-to-date method for central heating units is the Compensating Temperature Control System, which in effect regulates the temperature of the water in the system in accordance with the weather conditions outside.

Stoker fired furnaces, ovens, kilns, etc., can also be readily maintained at the required temperature by means of automatic temperature controllers. For the higher temperature furnaces, pyrometer controllers operating on the thermocouple system are generally used, but optical pyrometers are now also available for this purpose.

Both in the interest of fuel economy and as a safeguard for the stokers, it is often desirable to make use of " kindling " or " hold fire " controls for " off-load " periods. Also automatic change over time switches to change the control system from normal running to " hold fire " condition, and vice versa, are a convenience and a labour saving device.

Installations

Although the principles of underfeed stoker firing promote good combustion,

freedom from smoke is to some extent also dependent on other factors of application and operation.

It is therefore important that the stoker should be installed to the best advantage.

Such features as combustion height and volume, i.e., the height and volume of the combustion chamber, accessibility for removal of clinker and ash, adequate chimney draught, facilities for cleaning flues, protection for the mud ring in boilers, and so on, should be given due consideration.

Boiler houses are too frequently cramped, ill ventilated and ill lit, and in consequence, the boiler plant and its accessories tend to be carelessly operated and badly maintained.

In this connection the writer would like to add his tribute to those running many classes now being given for boiler firemen and to the efforts being made to raise the status of the small boiler house and its staff.

In the case of furnaces, flue sizes and arrangements are of the utmost importance. A layout used for hand firing may require considerable modification to be suitable for stoker firing. In all cases the advice of the stoker maker should be sought. Close co-operation between the user, the furnace builder and the stoker maker is the best guarantee of success.

Fuel

Coal. Coal is a very complex substance and it is not possible to issue a short and simple specification of suitable fuels, but it should be emphasised that the underfeed stoker will burn a wide range of coals. The tradition that nice clean washed singles are required, is a fallacy.

As a very rough guide it might be stated that the coal used should be bituminous and not highly caking. The size of the largest pieces should not exceed about $\frac{3}{4}$ in. to 2 in., depending on the size of the stoker.

The percentage of fines (particles under $\frac{1}{8}$ in.) should not exceed 30 to 40 per cent.

It is preferable that the ash content should not be greater than about 10 to 12 per cent.

The Underfeed Stoker Makers' Association publish a leaflet giving detailed information of suitable coals, and the Ministry of Fuel and Power, and also the coal suppliers should be consulted regarding the fuels available.

Coke and *anthracite* can be used in those underfeed stokers specially designed to burn these fuels.

Summing up, it is claimed that the underfeed stoker can play an increased part in this vital matter of Smoke Abatement. At the same time its adoption assists in saving fuel, and by giving controlled heat output, improves industrial efficiency.

(5) SMOKE INDICATING DEVICES

by

G. A. G. Ive

For many years the estimation of the degree of smoke emission from chimneys was based on visual observation relying on two characteristics of smoke, colour and opacity. The colour was judged by comparing it visually with standard colour charts representing various shades of grey, from light to dark, the accepted standard for comparison being the Ringelmann Smoke Chart which is divided into six sections. The first section representing " no smoke " corre-, sponds to 100 per cent. light transmission and the last section representing " black smoke " to 100 per cent. light absorption, the four intermediate sections are equally spaced in increments of 20 per cent. light absorption.

Determination by the second characteristic, opacity, relied upon an observer judging the degree of light absorption by reference to an object on the far side of the smoke stream.

In practice visual observation has obvious limitations, it is expensive and cannot be carried out in bad weather or during the hours of darkness and this makes it unsuitable for permanent recording. Also, it is generally agreed that in making light intensity or colour measurements the less we rely upon human judgment the more accurate the result

will be, as the visual response of the eye is dependent upon surrounding lighting conditions and varies considerably with fatigue.

With the development of the photo-electric cell, popularly known as the "magic eye" it became possible to dispense with human judgment and to design an instrument to indicate accurately and record smoke emission independently of weather and lighting conditions, and to sound an alarm if the smoke density exceeds a chosen value.

The photo-electric cell resembling in appearance a radio valve possesses the property of converting light radiations into electrical energy, the energy developed being proportional to the light intensity reaching the photocell. It comprises a small glass envelope containing two metal electrodes, the one, referred to as the cathode may be constructed from a disc of the metal ceasium which being light sensitive emits electrons when light shines upon it. The second electrode known as the anode, takes the form of a nickel ring and its purpose is to collect the electrons emitted from the cathode. The two electrodes are brought out to pins at the base of the glass envelope and the latter is either evacuated or filled with argon or a similar gas. In use the photocell is connected to a potential of approximately 80 volts, and when illuminated the sensitive cathode emits electrons which travel across the intervening space to the anode and give rise to an electric current of a value directly proportional to the incident light. The strength of the photo-electric current can be indicated on a suitable current measuring instrument, and if the instrument scale is calibrated in Ringelmann Smoke Units and the photo-electric cell illuminated by a ray of light projected across the path of a smoke stream the instrument will indicate smoke density.

It should, however, be mentioned that the current passed by a photo-electric cell is extremely minute and amplification is necessary before it will operate an alarm device. For this purpose a thermionic valve amplifier is employed and the increased current obtained permits more robust indicating meters to be connected into circuit although smoke meters are constructed utilizing a very sensitive indicating instrument directly connected to the photocell.

Although in principle the system is not complicated many precautions have to be taken to provide a reliable indicator capable of reproducing its readings accurately day after day, and by way of discussing the various considerations involved a commercial instrument will be described in detail.

The first essentials are a projector to throw a light ray across the smoke stream and a receiver to collect the light and concentrate it on to the photo-electric cell. The lamp employed in the projector is usually rated at 6 volts 24 watts and is energized from a small transformer, or, where a direct current supply only is available from a series resistance. Light from the lamp is concentrated by a silvered reflector into a narrow beam of approximately 4 in. diameter, the reflector position relative to the lamp being adjustable for focussing over any distance up to 40 feet. The photocell receiver, similar in appearance to the projector, is fitted with a focussing lens which collects the light rays and focusses them on to the sensitive surface of the photocell.

The light ray is projected on to the receiver through 4 in. diameter holes in the uptake or flue, and the optical components are protected from the flue gases by plate glass windows. Compressed air is passed over the windows to prevent deposits of soot which would give rise to false readings, and wherever possible the projector and receiver should be mounted on the input side of the induced draught fan where a negative air pressure exists. Air is then drawn in through air ports in the housings, and on its way through the units into the stack it passes over the windows and assists cleaning. In general an air pressure of approximately 2 in. water gauge over the maximum flue gas pressure is required to prevent sooting up, and on many of the smaller installations natural air cleaning is sufficient. A typical projector or receiver unit is shown by Fig. 1.

The photocell receiver is connected to the control unit which may be mounted in any convenient position within approximately a 40 ft. cable run. Also connected to the control unit is a mains supply and the smoke indicators and recorders. The control unit comprises a single stage thermionic valve amplifier together with sensitivity controls, and the whole is mounted in a cast iron housing arranged for wall mounting, and suitable for use in ambient temperatures up to 160° F. Obviously, the function of the amplifier is to increase in the value the minute photo-electric current and the photocell

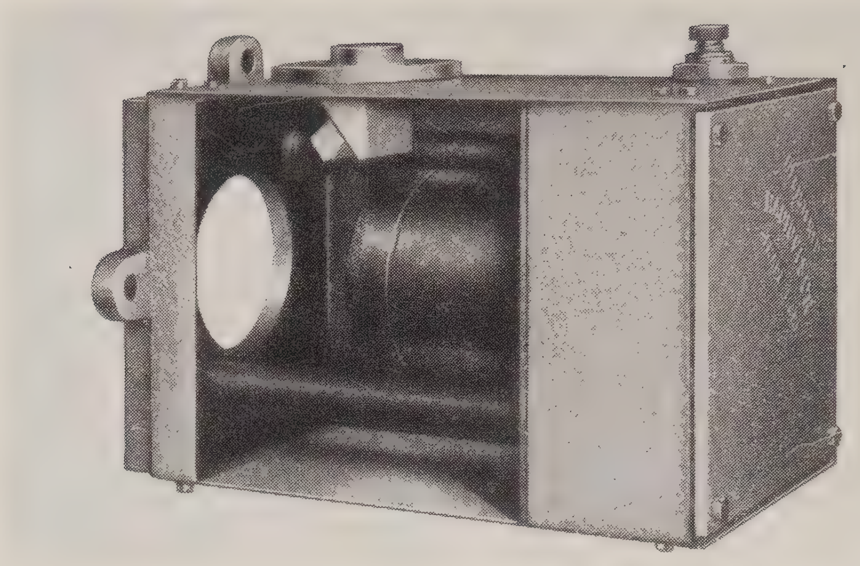


Fig. 1

is associated with a resistance net-work which is connected to the control grid of a thermionic valve. Thus the photo-electric current is amplified, and the output current of the valve follows faithfully the changes in photocell current brought about by variations in the incident light intensity and its instantaneous value is indicated by dial instruments which are sufficiently robust for continuous working in a boiler room.

The control unit has two adjustments, the one being a set light control, the other a set dark. The two controls can be adjusted independently of each other, the " set light " control serving to adjust the zero or light end of the indicating scale to the constants existing without reference to their absolute value. Likewise the " set dark " control adjusts the full scale reading of the indicating meter and the scale relationship is linear over a wide range of light intensity.

To facilitate the initial adjustment of the " set light " and " set dark " controls a small meter is provided in the control unit, and once set the unit requires very little attention but periodically, say every six months, the projector lamp should be replaced and the zero and maximum scale readings checked.

The actual smoke indicating meter really shows the percentage of light absorbed by the smoke and its scale is divided into Ringlemann units. Essentially a 6 in. scale current measuring meter, it is suitable for flush or projection mounting, and is usually installed on the instrument panel where its readings are easily observed by the boiler room attendant. The meter is, of course, wired back to the control unit and a modified type of instrument has an alarm contact and relay incorporated. The alarm contact in the form of a red pointer can be set to any chosen point on the smoke scale corresponding to a definite smoke emission. When the indicating pointer reaches the pre-set value on the smoke scale contact is made with the alarm pointer and the internal relay actuated. The contacts of the relay are connected to an alarm device, for instance, a Klaxon horn which sounds until the smoke emission falls below the pre-set value. An indicating meter having a Ringelmann scale is shown by Fig. 2. In addition to the indicating meter a continuous pen recorder can be installed and the recorder

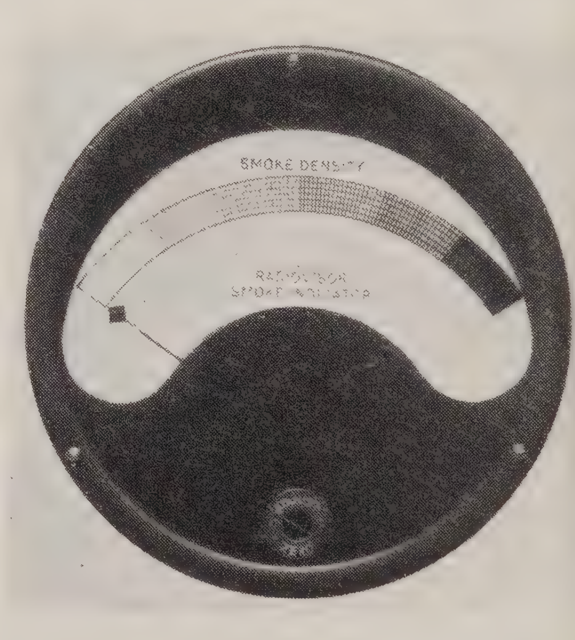


Fig. 2

plots in ink the smoke emission throughout the day and night. The chart, driven either from clockwork or a synchronous motor, travels at a speed of 1 in. per hour and lasts for a continuous running period of 40 days.

Fig. 3 shows a typical layout of a smoke indicating equipment, the installation of which is straightforward, the only real consideration being in the placing of the projector and photocell receiver. The location of these units should be made so that the glass windows do not quickly become sooted up, and the position chosen should be free from turbulence of the smoke stream otherwise false readings will be obtained.

The Smoke Abatement Officer is principally interested in smoke indicators as an aid to smoke abatement, but the equipment has other uses and is not restricted to the measurement of smoke emitted by coal or coke firing plants. Its indications are, of course, a guide to efficient combustion and are equally reliable on oil-firing or with any other smoke-producing fuel. The equipment is also employed to measure the exhaust smoke from diesel engines where the clearness of the smoke is as reliable a guide to combustion conditions as the smoke in the stack of a solid fuel plant. It has also been applied to the measurement of lead and tin smelting fumes where if the filters are not working correctly considerable quantities of these expensive metals are carried up the stack and lost to atmosphere. Yet another application is in the measurement of the smoke present in air heaters and where the products of combustion are employed for grain drying and processing. In these applications a more sensitive control unit is employed but the principle of operation is the same. Sometimes with very sensitive smoke measuring equipment variations in the projector lamp voltage will bring about changes in light intensity, and to prevent these changes from affecting the reading of the indicators it is usual to install a small static voltage regulator. Such a device maintains a constant voltage output regardless of considerable variations in the mains supply system which, therefore, do not affect the accuracy of the equipment.

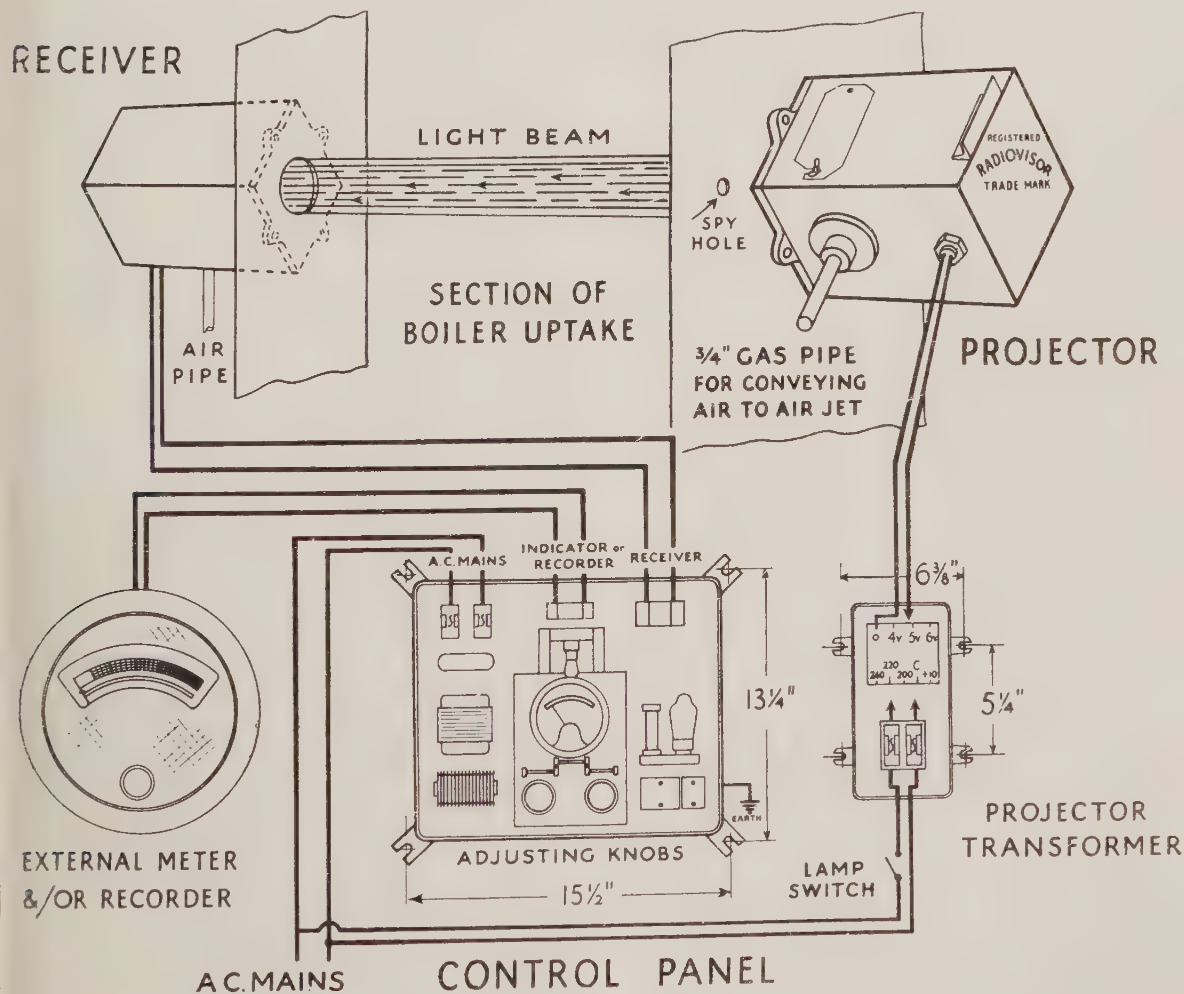


Fig. 3

Discussion

James Law (Sheffield) said he had been particularly interested in the five papers which had been submitted for discussion that morning and was sure that the information contained in these papers would be of value for future reference to everybody concerned in the smokeless operation of boilers. It was somewhat surprising in the year 1951 to find people who continued to support the hand-firing of boilers, and in this respect criticism was being made.

If engineering and combustion science had any real meaning surely the day when a boiler operator had to shovel fuel into a furnace and drag and rake that incandescent fuel bed had passed.

The most effective method of securing smokeless operation was to feed the fuel and air uniformly to the furnace, maintain a maximum temperature and reduce the " human element " to a minimum. This could only be achieved by mechanical methods—hand firing was never smokeless.

There had been a great amount of publicity about smoke eliminators and secondary air doors, which were tending to perpetuate these antiquated hand-fired methods. These doors were only effective on boilers to the extent that the boiler operator was prepared to manipulate them, and the price of £70 per boiler was out of all proportion to the cost of the material and labour put into them. The whole business appeared to have become a " money making ramp," and did more harm than good. Professor Ripper in a report published in 1896 stated that " each particular case requires its own special treatment. It is through want of appreciation of this fact that so many thousands of patents, which have been taken out for preventing smoke have proved failures."

He also stated " the coking stoker is in principle a perfect smoke preventer, whilst the sprinkling stoker emits more or less light smoke continuously where the draught is good.

Mr. Chadwick in his paper stated that " large size high volatile fuels offer no difficulty to smokeless combustion, but small sized fuel, on the other hand, has a large exposed surface per unit weight of fuel, from which the light volatiles are quickly distilled and liberated, which in the absence of sufficient secondary air will pass off in the form of smoke." In strong contrast to this, Professor Wheeler, who carried out five years research for them in Sheffield on this problem, stated " In all the tests carried out it was noted that the tendency to produce smoke increased with the size of the coal. With care of firing 'singles' could be used smokelessly, at any rate of combustion, but the use of larger sizes without the production of smoke was only practicable when the rate of combustion was high and a very hot fuel bed could be maintained."

In practice, it was found that either for hand firing or mechanical stoking smokelessness and high efficiencies were only obtained with " peas, beans and singles," whilst fuels either smaller or larger gave rise to loss of efficiency and smoke nuisance. Perhaps Mr. Newman would give further information with regard to this matter and tell them who was wrong.

Mr. Pearsall in his paper was particularly modest about the achievements of the coking and sprinkler stokers, nor did he give an indication why the use of one was preferable to the other. For highly fluctuating loads the coking stoker was not sufficiently responsive, and the difficulty of using sprinkling stokers was the tendency to deposit grit, even with graded fuel, in addition to which the sprinkler stoker was somewhat noisy in its action. For high duty work and robustness, the sprinkler stoker was as yet unsurpassed, but some form of grit arrestor was an essential appendage. It would be helpful if Mr. Pearsall emphasized this matter.

Mr. Law had been interested in Mr. Hayward's description of the chain grate stoker for shell boilers, but as yet it was much too early to offer criticism. Whether they would withstand the " high duties " expected of them and successfully burn the high ash content fuels continuously was yet to be discovered. Some colliery engineers are of the opinion that they would not take these low grade unmarketable fuels, but the experiments were being watched with interest, for there appeared to be ample scope for this type of stoker.

Of all the improvements that had taken place during the past twenty-five years, he knew of no piece of apparatus that had helped to reduce pollution compared with the underfeed stoker. For central heating boilers, vertical boilers, re-heating and heat treatment steel furnaces, it had bridged a " gap " that looked as though it would remain with them always, and

ıad helped to solve many of their pollu-ion problems. There was still some room or further improvement with regard to he formation of clinker, and the difficulty n preventing the fusion of ash round the uyeres. Again, when the stoker ceased o work, there was not sufficient air ntering the furnace to give combustion o the existing fuel bed, and smoke ıuisance was caused every time the control operates. These were not unsur-nountable difficulties, but were technical lefects which could be improved upon. He was of opinion that underfeed stokers could be developed for many more uses han at present. Some information with egard to ash fusion trouble and smoke emission during break periods would be ıelpful.

In conclusion, Mr. Law paid tribute to Mr. Ive for his concise description of the photo-electric indicator. This instrument n his opinion should be fitted to combus-tion control panels in lieu of CO_2 recorders, which were often misleading to the operator, particularly when the operator was unable to see his chimney top. His only criticism of these instru-ments was that there had been in the past a serious lack of servicing to keep them in working order. The more universal use of these instruments would undoubtedly reduce the amount of unnecessary obser-vation work which fell to the lot of the inspector, and help to give smokeless operation on boilers.

W. B. Kennedy (Senior Smoke Inspector, Manchester) complimented the Society on the standard of the technical papers presented that morning. He pointed out the disparity between Mr. Chadwick's remarks on preheated secondary air and those of the Fuel Research Station's publications. The firedoor advised by the Fuel Research Station was made for cold air admission and had a maximum secondary air opening of about 61 square inches. He asked what method of pre-heating and what temperature did Mr. Chadwick advise. He thought that Mr. Chadwick's remarks on the amounts of secondary air should be amplified. For instance, although a low volatile fuel such as coke with a volatile content of about 3 per cent. would theoretically require about 3 per cent. secondary air, in practice, according to the size of fuel and depth of firebed, it would require up to about 25 per cent. secondary air. Bitu-minous coal might need 50 per cent. secondary air, even though the volatile matter was only about 30 per cent., the explanation being that the whole of the excess air required was secondary air. He recollected that Mr. Duguid had pointed this out years before American research on the flow of air through fuel beds had been published.

Mr. Hayward's concise account of the performance of the chain grate stoker was very interesting, but could he state in precise terms the actual advantages of this stoker over that of a modern coking stoker ?

He asked Mr. Pearsall what he con-sidered would be the maximum rates of combustion that could be attained with the main types of stokers, using suitable and unsuitable fuels, without risk of grit emission. He asked this question because he had advised an industrialist that his proposed installation of a coking stoker in an economic boiler, with a maximum rate of combustion of 35 pounds per square foot of grate area, might under certain circumstances cause a risk of grit emission. This was all the more serious because other regulations limited the height of the chimney to 50 feet. He agreed with Mr. Pearsall that it was pre-ferable to burn bituminous coal in plant constructed to burn it efficiently, in fact this was recommended in the Simon Report, so that more coke would be released for domestic purposes. On the other hand, local regulations might forbid the emission of any smoke, therefore, to secure compliance, only so-called smoke-less fuel with gas ignition could be used in such plant. He understood that a Government Committee had been set up to investigate the advantages of mechanical stoking. This seemed another example of what Manchester does today, England thinks about tomorrow, because Man-chester had insisted for the past five years that all new installations burning bitu-minous coal must be mechanically fired. In fairness to the manufacturers, most of them willingly co-operated, and those who were reluctant had been surprised at the economies effected.

Mr. Kennedy wondered whether the makers of certain types of vertical boilers were aware of the elementary principles of combustion. Some had firedoors with insufficient provision for secondary air, and insufficient volume of combustion chamber, and dense smoke could not fail to be emitted if fired at a normal rating. He asked Mr. Day if any tests had been carried out with coke in underfeed stokers, and whether there had been any grit problems to contend with.

Under the various milk and ice cream regulations, the use of recording thermo-

graphs were compulsory, in order that the sanitary inspectors who enforced these regulations would be able to ascertain that their requirements were being carried out at all times. We could please ourselves whether we ate ice cream, he continued, but we were compelled to breathe smoke-laden air, even during the hours of darkness, when most smoke abatement legislation could not be enforced. If smoke abatement was intended to be taken seriously, surely smoke recorders should be provided on at least the large plant. He thought that the recorder firms had been slow in not exploiting the Fuel Research Station Report, in which it had been pointed out that serious fuel losses could occur through smoke emission, even though a CO_2 recorder showed a good reading. In his experience, smoke nuisances due to carelessness had been eliminated when smoke recorders had been installed. The constant check, day and night, made the staff smoke conscious. In another instance where the firemen, having a rather easy job during the night shift, were apt to let matters slide, a large siren was connected to the recorder, a moderate smoke emission set up a most terrific noise which was so unbearable that the firemen rushed to the controls immediately. This was an example of a smoke emission becoming a worse nuisance to the smoke makers than to the public.

G. W. Farquharson (Midland Joint Council for Smoke Abatement and Atmospheric Pollution) said we had had the views of the makers and designers of these types of apparatus, and the answer to many of the excessive smoke problems in the industrial field. "Complete combustion with efficiency" was the target of all Local Authority Officers engaged in this work and also the motto of the Fuel Efficiency Branch of the Ministry of Fuel.

Why then was it that this mechanical method of firing had not been universally adopted, not only to new plants, but also existing process furnaces?

They were told definitely that the underfeed type could be used for many processes, which they, as delegates, knew were a source of serious smoke pollution such as intermittent brick kilns, tile kilns and processes appertaining to the steel industry such as annealing and reheating. And yet they found that new kilns and furnaces were being built designed for hand firing and burning raw coal.

Was it the cost of automatic stoking that influenced the manufacturers? He did not think so because the saving in fuel helped to repay the initial cost. It could not be the advice given to any manufacturer contemplating such stoking arrangements because they knew good combustion was obtained. Was it the question of delivery? No doubt the authors could enlighten them on that.

His belief was that most manufacturers when contemplating the installation of mechanical stokers found that they were often informed that no guarantee of suitable fuel for the job was possible by the fuel distributors.

This apathy was what they had to overcome. There seemed a lack of direction or understanding on the part of the fuel overseers' offices, especially on the distribution side, that by supplying the type of fuel required they were in the main saving fuel, and incidentally reducing atmospheric pollution.

This, in his opinion, was the hard core of the problem.

S. H. Richards (Fuel Research Station) said that he would like to congratulate Mr. Chadwick on his paper. Mr. Chadwick was undoubtedly one of the experts of this country today on the subject of hand-firing. There was, however, one statement in the paper with which the speaker could not agree, viz., that "only those systems which employ pre-heated secondary air . . . can be used with any assurance of success." Experience at the Fuel Research Station had shown that unheated secondary air could be quite effective if properly directed and controlled, and the staff there would be glad to demonstrate this to Mr. Chadwick.

Referring to Mr. Pearsall's paper, Mr. Richards said that a great deal of very valuable information on coking and sprinkler stokers had been presented. To cover such a large subject in the limited time available, however, much of the information was necessarily summarized, and it was possibly as a result of this that in the speaker's opinion Mr. Pearsall had somewhat over-emphasized the advantages of the mechanical stoker and the disadvantages of hand-firing. Mr. Richards agreed that in many plants mechanical firing was preferable to hand firing, but sight should not be lost of the fact that for many years to come a very large number of plants would continue to be hand-fired, and it should be fully appreciated that hand-firing when properly carried out, could be just as efficient as mechanical firing. Time did not permit a detailed reiteration of the work on which this statement was based, but a full account of this had been given

n Fuel Research Technical Paper No. 55.

Dealing with a number of specific points in Mr. Pearsall's paper, Mr. Richards said he could not agree with the statement to the effect that in hand-firing one-third of the fuel was released as volatile matter during the first minute or so after firing. Tests at the Fuel Research Station had shown that this period was usually five or six minutes, which was quite long enough for the admission of the extra secondary air necessary to burn completely the combustible matter present in the furnace gases and thus prevent the emission of smoke. Referring to the quantity of excess air admitted as a result of opening the fire-doors during hand-firing, Mr. Richards said that this was much smaller than was popularly imagined. Under natural-draught operation the Lancashire boiler at the Fuel Research Station had been run at an average of 13.5 per cent. CO_2 (including the fire-cleaning period, during which the CO_2 in the flue gases fell to 8.7 per cent.). This alone showed that the quantity of excess air admitted could not be very great. For forced draught operation, where balanced draught is maintained in the furnace, it would of course be even less.

John Fox (Member) congratulated the five authors on their papers, each one of which contained a wealth of information of great use both to managements and to factory engineers, in spite of them being all miracles in the art of condensation.

The importance of hand-firing, at the present time, both from the point of view of promoting smokeless combustion, and also as regards fuel economy, could not be too strongly emphasized. Although Mr. Hayward stated that 40 million tons of coal were burnt annually in industrial boilers, and Mr. Pearsall gave the figure of 50 million tons as the annual consumption for shell-type boilers, it seemed quite certain that there were still some 40,000 boilers in the latter category which were hand-fired. It was probable that in these, by improving furnace conditions, a saving of some $2\frac{1}{2}$ million tons of coal a year could be achieved, and according to a statement made by the Minister of Fuel and Power in the House of Commons last December, his Ministry was well aware of this state of affairs, and of the reasons for it.

Mr. Hayward made reference to the poor standard of intelligence so often found with men operating hand-fired boilers. Nowadays this was not considered an attractive occupation, and it seemed that as regards intelligence, the quality of the stokers likely to be available in coming years would deteriorate. In this connection the importance of making automatic any scheme for admitting secondary air into the firebox should be stressed. Mr. Chadwick had tabulated the several methods which were commonly used. They were all sound technically, if properly worked, but here the human element came in. There was little doubt that the importance of secondary air was generally realized, but one did not hear nearly enough about pre-heating, or about turbulence above the fuel bed, the latter condition being very desirable when high volatile coals are consumed. The Fuel Research Station smoke eliminator fire-door was technically excellent, and would make possible of attainment efficiencies practically on a par with those reached with mechanical stokers. Unfortunately, it was not automatic and depended on human operation.

There was no doubt that modern mechanical stokers would deal with a very wide range of fuels, though no single design could be expected to deal with every class of coal, although some had a greater range than others, and in some instances that range would be likely to widen owing to detailed improvements in design.

Mechanical stokers were automatic, and they enabled frequent charges of small quantities of fuel to be fired. In those fitted with self-cleaning grates, or with an ash-extractor such as the Oldbury, there was no reason to open the fire-doors, and the pre-heating of secondary air could be quite easily catered for. Thus there should always be sufficient temperature to ignite the newly liberated hydrocarbons, while the tendency to place large charges of fuel on slow-burning fires was killed at the start.

As regards chain-grate stokers, having seen something of Mr. Hayward's work on them since the earliest days, it was fair to say that he made no claims that could not be substantiated. As regards coking-stokers, designs of these generally seemed to be less flexible in meeting varying loads than was the case with other types. Experience showed that they gave their best results with coals in group 2, which were firmly coking, so that no trouble was experienced with the moving bars due to riddlings. To show that shovel type sprinkler stokers could help in the matter of smoke abatement, several years ago some very satisfactory trials with burning lignite were witnessed in company with

Mr. Pearsall. At no time on those two days was more than a slight haze visible at the top of the chimney.

The speaker then asked Mr. Pearsall whether any trouble was experienced owing to small particles of coal becoming air-borne when sprinkler stokers were worked at high ratings.

As to boiler house instrumentation, it was agreed that a certain minimum of instruments is essential, but they must be understood by the stokers as well as being serviced regularly. If by virtue of proper combustion control due to the installation of suitable instruments, smoke was eliminated, it seemed that to operate on these lines was more sound intrinsically than to install smoke detector apparatus. The latter certainly had their uses, but as a means of correcting faulty combustion conditions, they might well be more difficult to follow than CO_2 apparatus, etc., although the speaker was in favour of such apparatus as the steam air flow meters made by Bailey and Kent, at any rate for the small boiler-house. They should, of course, be supplemented by exit-gas temperature indicators and draught-gauges.

Finally, a few random remarks. The taxation position was hitting the small firms very badly and it was often difficult to find capital for desirable, if not essential, replacement programmes and modernization schemes. By the installation of modern stoking plant, a real contribution could be made to smoke abatement as well as a real step towards conserving coal supplies.

In conclusion a plea was made for improved status of the boiler house operative, as well as for clean and light boiler-houses. A well-kept plant was generally an efficient plant, and the men took a pride in it. The financial return could not be assessed but it was real nonetheless.

P. H. Saunders (Chief Smoke Abatement Officer, Liverpool) said these excellent technical papers did credit to the Society and hoped there would be more of them at future conferences. He regretted having to offer some criticism in the absence of one of the authors, but Mr. Chadwick had stated that there were two things only which caused smoke. Actually, there were four ; lack of air and temperature, as Mr. Chadwick stated, with lack of turbulence which was most necessary for thorough mixing of air and volatiles, and lack of time for this mixture to burn. These latter factors were most important and because they were absent, for example, in the straight vertical boiler by reason of its design, bituminous coals could not be burnt smokelessly in that type by hand.

Mr. Law had already mentioned the next point but Mr. Saunders felt bound to emphasize it because the author's statement that large fuel offered no difficulty was the complete reverse of what members saw on the railway instruction films at Margate last year. He had always found smoke troubles when large bituminous coal was burnt. Agreed that the exposed surface, weight for weight, was relatively small, but that was the trouble. The interior mass of the large piece of coal is in a high state of distillation and coking, and upon a sudden demand for steam and corresponding stirring of fires, these large pieces are broken and the mass of volatiles released under conditions in which smoke is unavoidable. Mr. Saunders suggested that the ideal size for perfect combustion was the tiny particle of pulverized fuel, completely surrounded by oxygen.

In the same paragraph Mr. Chadwick had referred to combustion of CO and CO_2 in connection with the burning of light volatiles. Mr. Saunders thought that in such cases it was a matter of volatile hydrocarbons (CH_4, C_2H_2, etc.) burning to CO_2 and H_2O, but when starved of air, cracking into pure carbon and moisture and showing as black smoke.

On the method of hand-firing shell boilers, Mr. Saunders did not agree that the dead plate or coking method of hand-firing was inefficient ; in his opinion it was, he said, a very good method and the only efficient one of firing shell type boilers with bituminous coal under light and constant load. He agreed that it could be carried out inefficiently, as could any other method.

Mr. Saunders said that hand-fired vertical boilers were the bane of the smoke inspector's life in these days of coke shortage. He himself had found some improvement in smoke emission by firing bituminous coal around the periphery of the fire grate, keeping the centre incandescent, but said again that straight vertical boilers could not be hand-fired smokelessly with bituminous coal under full load.

Regarding chain grate stokers for shell type boilers, he said he had seen this type in operation with considerable success on low grade fuel and would like to ask Mr. Hayward if the caking quality and ash content had any bearing on this type of stoker.

Regarding Mr. Pearsall's recommendaion of solid fuel with up to 25 per cent. of fines for his sprinkler stokers, Mr. Saunders said his worst troubles in Liverpool had been grit from sprinkler-fired boilers using slacks with high percentages of fines, and in spite of controlled draught and conditioning of fuel the nuisance had continued. Only by obtaining, in some cases, washed graded fuel without fines (by courtesy of the Ministry of Fuel) and in other cases by conversion to low ram stokers or enlargement of flues, had the nuisance been overcome. He was all for mechanical stokers but advocated careful selection of the type to accommodate the present day class of low grade fuels.

Regarding underfeed stokers, he endorsed all that had been said in their favour, but said he had had some of the worst black smoke emissions from this type of stoker using a highly caking type of fuel. Mr. Day had warned against this in his paper, but manufacturers had not much choice these days and this type of fuel tended to form a crust over the fire which had to be broken up by hand, when large volumes of volatiles were released and appeared as black smoke for one or two minutes at a time. He asked if Mr. Day could suggest a remedy for this in addition to one Mr. Saunders had tried, of mixing coke breeze with the fuel and which, although helpful, was not entirely successful.

Finally on smoke indicators he asked Mr. Ive what remedy he could give to overcome switching off the indicator when excessive smoke could not be prevented.

N. Bastable (Chief Sanitary Inspector, Barking) commented on the phrase Mr. Ive had used when he referred to smoke as being something which was "relative and not specific." Smoke had always been something that was relative because there had never been any legislation which had attempted to fix any unit of measurement. This defect in legal control resulted in all sorts of standards and required a Ringelmann Chart divided into six to try and define which phase was relevant. Many men-hours of sanitary inspectors' time were spent in observing chimney emissions and this had been so ever since the Public Health Act of 1875.

Dr. Bronowski had stated that our waste is the greatest potential asset of this country. Mr. Bastable asked whether we should continue to waste the intelligent manpower of sanitary inspectors by continuing to watch the emissions from chimneys when with the use of indicators this work could be done much better mechanically, and if related to a legal unit of emission, be satisfactory in the Courts. He suggested that in the same way as we have unit measurements such as the ohm, volt and the watt, we could prescribe a unit of smoke, give it a name, and plot it on the smoke recorder. There were already meters on boiler house plants which were required by law to be provided and operated, namely, the water meter and the steam meter, and in the same way the dairy industry was required to attach and keep in constant operation a pasteurizing record. This should be required similarly in relation to smoke. Mr. Bastable ended by calling upon every local authority to press for photo-electric indicators to be compulsorily fixed upon every boiler flue and for a unit of smoke measurement to be nationally adopted.

Mr. Ive had stated in his paper that the instrument which was now in operation was an accurate mechanical apparatus capable of recording smoke emissions and the only issue therefore outstanding was to define legally the unit of smoke which it would be permissible to emit.

Authors' Replies

C. E. Newman (for V. R. Chadwick) said that he regretted that in the time allowed the many interesting points emerging from the discussion could not be answered adequately, but it was clear that Mr. Law had a decided bias against hand firing. This attitude was very puzzling as he ignored the law of economics. There were many small steam plants using a few tons of coal per week which did not warrant the expenditure of machine firing. Hand firing was quite efficient and there were many plants operating at over 70 per cent. efficiency after educating the firemen and putting the plant in order.

He agreed with his remarks on secondary air doors as being a "money making ramp" and added that most sales were due to "slick methods." It was illuminating that as far back as 1896 the method used today of "each case requiring its own treatment" should have been advocated.

In regard to large size coals, it was common sense that as there were interstices between the lumps (which also had a relatively small surface distilling area) it followed that air could find its way through such spaces and mix with the volatiles liberated. If the furnace temperature was correct, large coal would give less trouble from smoke than smalls

which pack closely and offer resistance to the air for combustion. He would suggest that the extract of a part of Professor Wheeler's paper from the context was dangerous. All his experience contradicted the statement that "singles could be used smokelessly at *any rate* of combustion." Where the rate was low the temperature was low—result, black smoke.

Mr. Kennedy raised the question of degree of pre-heat for secondary air : this must, unless a separate pre-heater was used, vary with the plant in use, but a pre-heat of 200°-500°F. could be obtained by some of the plants in operation today. which took advantage of the heat available in the refractory behind the furnace fronts. If secondary air was necessary when burning coke (and this could only be determined by a flue gas analysis) it was evident that either the spaces in the grate were inadequate or the fuel bed was too thick. The amount needed in any case was so small that the louvres on the firing doors, with natural draught, should be capable of admitting the secondary air.

Mr. Richard's remarks had been conveyed to Mr. Chadwick and it was refreshing to have his views on the special door made originally at the Fuel Research Station. This was, of course, well known, and would do excellent work correctly handled, but it called for skilled use and was applicable under natural draught or induced draught conditions. It was, he believed, not advocated with modern balanced draught plants. His remarks regarding admission of air on opening of fire doors were welcome, and would, he hoped, dispel the popular idea of "loss through open firing doors."

Mr. John Fox struck the right note and he was glad he supported his appeal for a more universal use of the classes provided under the Ministry of Fuel and Power scheme, etc., for the education of that hard working, and often misunderstood, "man with the shovel."

Mr. Newman reminded Mr. Saunders first of his reply on Mr. Chadwick's behalf that when writing the paper it was assumed that all those present were conversant with the "three T's"—Time, Temperature, and Turbulence. In the absence of temperature it was useless admitting oxygen. The paper was based on practical experience and not theoretical possibilities. Secondly, of the danger of taking a sentence on the efficiency of deadplate firing from the paper without the relevant following statement which gave the author's reason for inefficiency often found with such firing.

Before attending the Conference he called at a Works in Southport where, with fan forced draught, mechanically fired by a shovel type stoker, Lancashire coal with a volatile content of over 30 per cent. was being used smokelessly at a rate of over 50 lbs. per sq. ft. of effective grate area. The grate had a turbulent zone and the fires the necessary temperature.

C. H. G. Hayward expressed some surprise at Mr. Law's suggestion that "it was much too early to offer criticism" of the chain grate stoker and that "experiments were being watched with interest." He was evidently unaware of the fact that chain grate stokers had been in successful operation in shell boilers since 1944, over 1,000 stokers having been fitted ; of these over 180 were fitted to Colliery boilers burning a wide variety of low grade, high ash fuels and obtaining outputs far in excess of anything previously experienced. These machines were in continuous operation under exacting colliery load conditions and considerable savings in labour and fuel were being regularly reported. In addition, smoke had been completely eliminated.

In reply to Mr. Kennedy, Mr. Hayward stated that a comparison between the two types of stoker at such a conference would be very undesirable. He would be happy to give Mr. Kennedy the information he required on a more suitable occasion. Mr. Farquharson had asked whether long delivery was the reason for not fitting mechanical stokers. Mr. Hayward suggested that a delivery of 8-9 months for the chain grate stoker was not unreasonable in these day.

Mr. Richard's statement that hand firing could be just as efficient as mechanical firing, might apply to the Fuel Research Station where firing by an expert under the control of scientists was possible. It was common knowledge however, that in industry today the type of man who could or would hand fire a boiler correctly just did not exist.

Mr. Fox's remarks on the chain grate stoker were appreciated as also was his support for instrumentation.

Replying to Mr. Saunders, Mr. Hayward stated that whilst the chain grate stoker would deal with most types of fuel, some very strongly caking or highly swelling coals could cause difficulty but this also applied to any make of stoker. There had been no difficulty in burning coals with ash contents up to 40 per cent. but of course it was necessary to clear ash

its more frequently and it was for this eason that the ash extractor has been eveloped.

H. E. Pearsall said that Mr. Law was ble to speak with a great deal of knowedge upon mechanical stokers, and aised several very interesting points.

He agreed that the sprinkler stoker was nore responsive than the coking stoker nd, therefore, more suitable for meeting highly fluctuating load. Dealing with is remark upon grit emission, this was argely due to the fact that the sprinkler toker was more responsive than the oking stoker, and during the periods of verload, the rate of fuel supply was very nuch higher, and it was a fact that as the ate of burning increased the tendency or carry-over increased more rapidly.

It was perhaps true that the old type of sprinkler stoker was somewhat noisy, out in recent years the noise has been considerably reduced, and although not quite as silent as the coking stoker, it was no longer objectionable.

Mr. W. B. Kennedy had made reference o the maximum burning rates with the different types of stokers when using suitable and unsuitable fuels. It was mpossible to give Mr. Kennedy a definite answer, and he was probably quite aware of this.

With a good grade of fuel which was free burning and has a relatively high ash fusion temperature, a burning rate of about 40 lb. per sq. ft. with a sprinkler stoker and perhaps a little less with a coking stoker should be quite satisfactory.

On the other hand, there were plants on which a higher rate of burning has been possible, but careful adjustment of forced and induced draught was very necessary.

So far as unsuitable fuels were concerned, some of these could only be burned at very low ratings, and it might be necessary with a particularly bad fuel to go down to even 25 lb. per sq. ft. of grate. He would go so far as to say that with unsatisfactory draught conditions grit emission could be produced at almost any rate of firing.

He was pleased to note that Mr. Kennedy agreed with him that bituminous fuel should be consumed on shell boilers, and he presumed he agreed that the problem to face was not the burning of smokeless fuel, but the burning of fuel smokelessly.

Mr. S. H. Richards of the Fuel Research Station had a wealth of information upon the performance of the plant at the Research Station. Having seen the installation he knew that he had obtained very valuable information.

Mr. Richards had called attention to the fact that many boilers would be hand fired for many years to come, and stated that hand firing when properly carried out could be just as efficient as mechanical firing. Of course, Mr. Richards put his finger on the case for mechanical firing with the words " when properly carried out," because it was seldom that hand firing was properly carried out, and however efficient a boiler operative was first thing in a morning, he certainly deteriorated in efficiency during eight or ten hours of firing. Furthermore, however frequently he fired the boiler the amount of fuel put on during each firing was more than was put on by a mechanical stoker, and he could not put the coal on without opening the fire door.

Mr. Richards stated that the Fuel Research Station boiler was run at an average CO_2 of 13.5 per cent. including a cleaning-out period. This, of course, was remarkably good firing, but by stating that during the cleaning-out period the CO_2 fell to 8.7 per cent. he again puts his finger on the inefficiency of hand firing. With some coals cleaning-out could be carried out very quickly, but if the coal tended to stick to the bars the period might become a lengthy one.

Mr. Fox confirmed that mechanical stokers could operate without smoke emission and referred to trials which they carried out together with a very poor quality of lignite. He would, no doubt, remember that to obtain the necessary evaporation with this lignite, the burning rate was exceptionally high and in addition the ash residue was only powder. Nevertheless, there was no apparent grit emission problem. As already mentioned, incorrect draught control was often responsible for grit emission.

He was all in favour of an improved status for the boilerhouse operatives. A good operative can save a very large amount of coal and similarly a poor operative can waste a large amount.

Mr. Saunders seemed to have been unfortunate with regard to grit emission on a number of plants. He maintained that he had had trouble with grit emission from sprinkler stokers when using slacks with high " fines " content. He did not state the amount of " fines," nor if it was greater than the 25 per cent. which he had suggested.

Mr. Saunders mentioned that in some cases the trouble was overcome by using

a washed graded coal and in others by an enlargement of the flues. A high gas velocity was, of course, inducive to carry-over and whenever possible flues should be designed to keep down the velocity to a reasonable figure. It would have been helpful if Mr. Saunders had given them a little more information upon the rating of the boilers. Were they called upon to meet fluctuating loads and did the carry-over occur whilst the stokers were meeting these heavy loads?

He entirely agreed with his remark that the type of stoker to be installed depended on the conditions which had to be met and the fuel which might be available.

Colin C. Day said that Mr. James Law in his interesting contribution to the Discussion raised two important matters in connection with underfeed stokers.

In boilers, due to the presence of water spaces, the temperature conditions in the combustion chamber were comparatively cool, and the removal of clinker should not present difficulties, in fact a formation of light clinker which was not highly fused provided a convenient means of removing ash from the fire.

Unfortunately boiler firemen only too often liked to see a thin and brilliant fire and abuse the abundant supply of air made available to them by the fan. This use of unnecessary excess air was not only inefficient but tended to cause the ash to form into a hard slag round the tuyeres, which could be difficult to remove. The answer in such cases was of course simple—adjust the air supply correctly.

A "blacksmith hearth" type of fire must be avoided—the operator should aim at maintaining a "slow lazy fire." Some underfeed stokers were fitted with an automatic air controlling device.

In the case of high temperature furnaces the problem could be more difficult, and here the ash fusion point of the coal should be watched. Also the design of the combustion chamber and the choice of the refractories for the hearth and walls of the combustion chamber played an important part.

The leaflet on fuels issued by the Underfeed Stoker Makers' Association stated that generally speaking an ash fusion point of not less than 1,250°C. gave the best results.

It was suggested that smoke emission due to break periods usually was of short duration and was comparatively light.

In many cases stokers were operated with an unnecessarily high feed with consequent frequent stops. Adjustment of the fuel feed to be just in excess of peak demand gave the best efficiency and less frequent stops. Some models used automatic feed control in which case, for normal load fluctuation, the stoker was not stopped.

Summing up, it was claimed that regulation of fuel feed combined with correct air adjustment would give an operating condition which would largely remove the two objections raised by Mr. Law, namely, unmanageable clinker and smoke at "off" periods.

Mr. W. B. Kennedy, in his very instructive remarks mentioned the use of coke in underfeed stokers.

During the first few years after the war, when coke was more plentiful than coal, coke was quite successfully burnt in many standard type underfeed stokers, but the rate of wear of the parts in contact with the coke was high due to the abrasive nature of the fuel.

At the present time underfeed stokers specially designed for burning coke are marketed.

Regarding the problem of grit, coke being a light fuel and the fire bed not being bound together in any way by tarry products, it is natural to expect that there might be more grit emitted than is the case with a coal fire. Fortunately, however, the open nature of the fuel permits the use of a deeper fine bed, which tends to compensate for the open texture of the fire and lightness of the fuel particles.

The use of bituminous fuel mixed with the coke helps to bind the firebed together and thereby reduces the possibility of grit and this also reduces the abrasive action of hard coke.

In practice, coke burning underfeed stokers are quite extensively used, but at the present time the relatively high cost of coke compared with coal does not encourage their wider adoption.

Mr. G. W. Farquharson was undoubtedly correct in his statement that a great many kilns and furnaces were still being built for hand firing with coal, which could readily be fired by underfeed stokers with an improvement in fuel economy and avoidance of serious smoke pollution.

It might be as Mr. Farquharson suggested that manufacturers were influenced by the question of capital expenditure, but perhaps also in addition by sheer caution; so many manufacturers insisted on waiting for their neighbours to try out new methods first. Also furnace and kiln builders were not without blame.

Furnace builders displayed the greatest

nthusiasm and ingenuity in designing nd building furnaces embodying the more xpensive sources of heat—electricity, gas, nd oil, but seemed strangely apathetic vhen it came to firing with solid fuel.

Provided there was close and undertanding co-operation between the furnace builder, the stoker maker and the user, hen almost every type of heating process which could be carried out by hand firing could be much better performed by an underfeed stoker.

Regarding the matter of fuel allocation, the importance of this was fully appreciated by the manufacturers of mechanical stokers, and the Combustion Engineering Association was keeping in close touch with the Ministry of Fuel and Power on this matter.

Mr. P. H. Saunders raised the important question of the effect of the caking qualities of the coal. In general, strongly caking and excessive swelling coals were not considered suitable for underfeed stokers when fired alone. Recommended coals should have an agglutinating value of between 5 and 8.

If highly caking coals might have to be used, then it was advisable that a stoker with a considerable margin of capacity should be supplied to reduce the rate of burning per unit area of grate. Mr. Saunders' method of mixing coke breeze with strongly caking coals was interesting and should be decidedly beneficial in reducing caking, provided reasonably thorough mixing can be obtained.

G. A. G. Ive said there was of course no method to prevent a boiler-room attendant from switching off his smoke indicator other than sealing the switches, which was usually undesirable. If a recorder was included in the installation, however, it would at least be seen when, and for how long, the instrument had been switched off. Someone in authority could then take steps to prevent unnecessary switching off.

POLICIES FOR THE PREVENTION OF INDUSTRIAL AIR POLLUTION

(I) AT THE COLLIERIES

Policy for the Prevention of Atmospheric Pollution with an Example of One Installation Recently Completed

by

N. Higginson, M.A.M.E.M.E., A.M.I.MIN.E.

On Vesting Day the nationalized coal industry took over about 4,500 steam boilers ranging from Lancashire boilers built before the turn of the century to modern forced circulation high pressure water tube boilers. The Board operates, at the moment, about 4,000 Lancashire boilers, of which about 3,500 are hand fired. Growing coal output and mechanization underground have increased the amount of power required at the individual collieries considerably and many are finding it difficult to supply enough steam with the existing boilers. As outlined in the National Plan, much of the surface equipment at collieries will be electrified. It is the intention to reorganize the generating plants at the collieries by erecting modern central power plants which will be supplied with low grade fuels or obtain the electrical energy from the British Electricity Authority's network where this is more economical. This is the long-term plan. It will take many years before it can be implemented.

Until such time as the over-aged existing plants have been replaced by modern generating stations, many thousands of Lancashire boilers will have to remain in operation and the Board are making considerable efforts to modernize the existing plant. The changeover from hand-fired furnaces to mechanical stokers allows us to burn a wide range of fuels efficiently and smokelessly and with a considerable saving of labour. Conditions in the coal industry change from pit to pit and although there can be a general plan, each pit has its own specific problems. The following paper describes how the problem of smoke abatement has been solved at an individual colliery in the Midlands and a reference to other specific cases of smoke abatement.

All over the country similar efforts are being made and although it will take some time before the effects will be felt on a large scale, the joint efforts will make themselves felt after some time.

Chain Grate Stokers fitted to Lancashire boilers at a Warwickshire Colliery

At the Vesting date the colliery referred to was provided with two boiler plants, one plant of six boilers steaming at 100 lb. p.s.i. and the other of five boilers steaming at 165 lb. p.s.i. Both plants consisted of Lancashire type boilers with steam jet forced draught furnaces which were hand fired using 0 to 1⅜ in. Nutty Slack. It was decided to eliminate the low pressure boiler plant mainly by discontinuing the use of steam produced compressed air as a power medium and to electrify the pit completely. It was estimated that the low efficiency of compressed air together with underground installation of the colliery main haulage, electrically driven, would so reduce the steam demand as to enable the low pressure plant to be dispensed with. The original main haulage was by surface steam-driven endless rope passing down the mine shaft.

After due consideration final arrangements were made to add a further boiler to the high pressure plant making six in all to power the mine by supplying steam for winding engines, heating, and electricity generation. The high pressure plant was well housed and arranged being only ten years old and the problem of selection of the best type of furnaces and/or stokers presented itself. Not the least consideration was the serious complaints being received almost weekly about smoke nuisance. These complaints whilst completely justified were made in greater number and were pressed by the Local Authority more

energetically after the Vesting date. Little complaint had been made previously and it was realized that the change in ownership of the mining industry had brought added responsibility. An assurance was given to the Local Authority late in 1947 that the capital approved for the new power scheme at this colliery would be applied with due consideration for smoke abatement and nuisance elimination at the completion of the scheme.

At the majority of collieries where winding is carried out by steam engines the steam load varies over wide ranges and indeed over very short periods of time. Coal face and other underground mechanization has widened these ranges since the running of large winding engines at maximum winds per hour often coincides with the maximum demand for electricity and/or compressed air. At the start of a working shift these engines often run unaccompanied by heavy electrical and compressed air demand and the steaming plant is consequently required to be capable of quick appreciation of heavy increases in evaporative rate. On the shift or shifts which do not produce coal it is necessary to keep more boilers under steam than is justified by the hourly evaporation rate since winding may take place without warning for men, materials, and dirt, etc. Two shifts on coal production to increase output has not helped the problem of meeting these widely fluctuating loads.

Bearing in mind this load problem and considering the age of many of the Lancashire boiler plants, the inconsistent, and low quality of the fuel burned and the scarcity of skilled stokers it will be realized that the problem of smoke abatement at collieries is one linked with other problems and these were in general those to be overcome at the colliery now being discussed. They were as follows :

(1) Smoke emission arising from simultaneous hand fuel charging in many Lancashire boilers on the battery so as to meet sudden steam demands with consequent incomplete combustion. To reduce grit emission when burning fine fuels.

(2) To eliminate a traditional designation of "firehole" to the Colliery Boiler Plant and to remove heavy toil associated with hand firing thus inducing more intelligent personnel to work the plant.

(3) To increase efficiency by better control of combustion and by provision of stoker plant capable of increasing steam output to demand by operation of controls in conjunction with instruments and to eliminate loss of coal output due to low steam pressure.

(4) To effect manpower savings.

(5) To reduce the number of boilers to a minimum by achieving comparatively high average rates of evaporation with low quality fuel thus keeping maintenance costs down, even with a greater quantity of mechanical plant in use than hitherto.

(6) To burn a greater range of slacks—increasingly becoming available at the collieries due to mechanization. Low quality slacks arising from cutting in or near inferior bands in the seam were required to be burnt at the colliery.

After careful consideration it was decided to install six pairs of chain grate stokers to the six high pressure Lancashire boilers, the sixth boiler being installed before the six low pressure boilers were eliminated. The 150 ft. high chimney 6 ft. dia. attached to the high pressure plant was considered to be of limited capacity with a low exit flue gas temperature, and to more easily deal with peaks an induced draught fan requiring 60 h.p. was installed for use as and when required.

The six problems enumerated previously appeared to be solved when the merits of this type of stoker applied to Shell boilers were considered. The plant was already equipped with economisers, superheaters, feedwater regulators and steam jet flue blowing equipment. Coal conveyors to the stokers were arranged and the ash was to be drawn out with a long withdrawal scoop to an ash conveyor of the wet type arranged below the firing floor.

The scheme was completed by January, 1950, and as will be seen from the Appendix it has resulted in a saving arising from the stoker plant installation alone of 4½d. per ton of coal output or £9,370, per annum for a capital outlay of £21,000. The elimination of compressed air power resulted in savings of a higher amount but they are not concerned with this paper.

Much greater reliability in steaming pressure has resulted. A complete absence of smoke for nine-tenths of the day is observed and at other times only a very light wispy emission takes place and the smoke nuisance has definitely been cured. It is remarkable that at times when the

load is highest and subject to the widest fluctuations smoke is never experienced beyond that described. Grit emission is negligible mainly due to an undisturbed fuel bed working with low draught pressures.

Since the plant was put to use further improvements are now in hand including the installation of ash extraction conveyors integral with the chain grate stokers which conveyors discharge direct to the main ash conveyor below the boiler house floor. One pair have already been fitted and they have proved successful ; others are now on order. To show pictorially, the state of the chimney top and plant at the colliery photographs are reproduced herewith :

(*a*) Chimney top after completing scheme.

(*b*) General view showing stokers and firing floor.

(*c*) Chimney top at a large Warwickshire colliery for which new equipment of a similar nature is now on order.

Fig. (a) top right, Fig. (b) above, and Fig. (c) over

Fig. (c)

Other Cases of Smoke Abatement Interest

In the Warwickshire area another colliery is burning 0-⅛ in. fines screened from Run of Mine, the calorific value being as low as 7,000 B.Th.U.'s per pound. This fuel is fired in three 18,000 lb./hr. water tube boilers by the pulverized fuel method. Smokeless combustion is achieved at all times.

Capital has also been approved for fitting further chain grate stokers to a battery of eight Lancashire boilers at the largest colliery in Warwickshire. These stokers will be fitted from the start with ash extraction conveyors. It is with complete confidence that we await results from this installation having had our experience with the colliery mainly discussed in this paper.

Before leaving examples of smoke abatement I would mention the fitting of secondary air arches to forced draught hand-fired furnaces. These perforated arches are fitted at the door end of the grate and are connected to the primary air supply, the air for over fire use being controlled by a small damper. Over 34 pairs of these arches and controls have been fitted in the Warwickshire area of the National Coal Board and they are doing much to reduce smoke emission as a short term measure.

Conclusion

As stated in the opening remarks the text of this paper is not intended to give the impression that mechanical stokers will be necessary in every case or that chain grate mechanical stokers are the only type where mechanical firing is required. Suffice it to say that the National Coal Board is fully aware of the difficulties associated with old plant and smoke nuisance is one of the design points considered where changes perpetuating steam production at the colliery are planned. The author would like to express thanks to the Chief Engineer of the National Coal Board for permission to give this paper with its appended data.

APPENDIX

National Coal Board
Colliery BP 1(05)

The following results were obtained over *one week* and include the full 168 hours working.*

(*a*) Mixed Nutty Slack and Crushed Boiler Coal—397 *tons* 12 *cwts.*

Size limits		
over ¾″	..	9.2%
¾″—½″	..	8.4%
½″—⅜″	..	9.4%
⅜″—⅛″	..	32.6%
Below ⅛″	..	40.4%

Gross C.V. as fired 10.280 B.Th.U./lb.
Nett C.V. as fired 9.858 B.Th.U./lb.

(*b*) Average Boiler Pressure over the week 148 lb. p.s.i. (blow off 160 lb. p.s.i.)

(*c*) Average steam temperature : 500° F.

(*d*) Average feed water Temperature : 144° F. (inlet to economisers)

(*e*) Average feed water temperature : 285° F. (outlet from economisers).

(*f*) Average flue gas exit temperature : 495° F. (chimney base).

(*g*) Evaporation per lb. of fuel fired : 5.75 lb.

(*h*) Heat account calculated on nett C.V. of the fuel :

Overall thermal efficiency	..	67.4%
Loss in chimney gases	..	23.4%
Combustible in ash loss	..	5.0%
Radiation and unaccounted		4.2%
		100.0%

(*i*) Fire thickness range 3 in to 5 in.

(*j*) Stoker grate speed range 7 to 28 ft. per hour.

(*k*) Observed chimney top—clear all the week except for one occasion when a very light wispy emission was seen lasting 10 minutes.

Savings. New Installation of Mechanical Chain Grate Stokers and Auxiliaries

(1) Weekly efficiency with old plant 50%
(2) Weekly efficiency with new plant 67%
(3) Fuel saving per week 95 tons.
(4) Saving arising from use of lower quality boiler fuel 2s. per ton of fuel burned.

*Weekly tests of this nature with the results carefully averaged enable proper balance sheets to be drawn up. The results are not so spectacular as given by selected spot tests or even as given by 8-hour tests, but they are indicative of the true state of affairs and reflect what will be seen in the monthly cost sheets so carefully drawn up in the National Coal Board Organization.

(5) Manpower savings: 21 manshifts per week.
(6) Gross savings per annum: £12,100.
(7) Capital Outlay: £21,000.
(8) Debit by Depreciation and Interest on Capital: £2,730 per annum.
(9) Nett savings per annum: £9,370.
(10) Savings per ton of coal produced from the mine: 4½d.
(11) The increased steaming reliability is not measurable in terms of money—production loss, from low steam pressure, has now been eliminated. Nuisance from smoke emission is cured removing difficulties with Local Authority.

(2) GAS

by

J. W. Denton, G.M., M.INST.GAS.E., M.I.MECH.E., M.INST.F.

Contents

1. Object:

The object of this Paper is to detail some methods employed in carbonizing bituminous coal to provide smokeless fuels, gas and coke, and show that the processes themselves give rise to a minimum of atmospheric pollution.

2. Necessity for, and effect of, processing bituminous coals:

Whilst there are considerable quantities of anthracite and hard steam coals available in this country, approximately 90 per cent. of the coal mined is of a bituminous nature and containing 20 to 37 per cent. volatile matter (i). Domestic consumption alone, at an efficiency of only 20 per cent. accounts for 50 million tons of this bituminous coal contributing thereby to smoke nuisance. When it is realized that this smoke largely represents the volatile matter which, in a Gas Works, is, by distillation, converted and distributed as a clean gaseous fuel, the importance of controlled processing to obtain maximum thermal efficiency and minimize atmospheric pollution can not be too strongly emphasized.

Dr. Parker, Director of the Fuel Research Station, tabled the main uses of coal and estimates of pollution in Great Britain during 1948 (ii). The total quantity of coal consumed throughout the whole country was 190 million tons, which produced some 2 million tons of smoke, 0.6 million tons of ash and 4.7 million tons of sulphur dioxide. Of the 190 million tons, 24 million tons of coal was carbonized in Gas Works, giving a pollution of only 0.1 million tons of sulphur dioxide and negligible quantities of smoke and ash.

The Gas Industry, in appreciating the necessity for the efficient carbonization of this valuable coal, by its distillation methods contributes to the elimination of pollution. Modern gasmaking plants distill the coal in a continuous and enclosed process, recovering all by-products, most of which are highly valuable.

Throughout the war years the Ministry of Fuel and Power, through the invaluable Simon Report, directed much attention to efficiency in the utilization of coal, and in this respect were supported fully by the Institution of Gas Engineers who contributed research work and practical application. The necessity to take steps against pollution is also realized throughout the Industry and Works are being progressively redesigned for increased thermal efficiency and at the same time clean operation.

3. Disposition of Gas Works:

Gas Works were invariably sited in the geographically lowest situation adjacent to consumers, but modern methods of distribution, coupled with the advantages arising from integration, now allow Works to be sited in relation to transport facilities

d general economic considerations. odern design is such that there should no objection to an architecturally de- ned Gas Works being placed in any mmunity, as the degree of control in process eliminates any concern arising m the problems of atmospheric pollu- n or other nuisance.

The Industry is well aware of the im- rtance attached to aesthetic considera- ns and clean operation, and its future licy envisages efficient large Stations ed at focal points where best they can eet the increased domestic and industrial mand for the two smokeless fuels, gas d coke.

The building of a modern Works of in- eased capacity will not detract from the ienities of the district, but in fact the olition of smaller Works and the rbonization of coals in larger and more icient units will contribute to smoke atement in general without creating a ioke nuisance in the vicinity of the ations.

Torquay Gas Works :

There are many Gas Works in the untry designed on lines similar to orquay, but it must be realized that local rroundings determine the type of chitecture and general treatment of the e.

Torquay possesses so many natural lvantages that a comparison aesthetically these Works with those in an industrial wn is unfair, but nevertheless many ations are operating with similarly low ollution.

Some twenty years ago the Local uthorities of Torbay expressed concern garding the detrimental effect of the orquay Works which are sited adjacent the shore of a very beautiful bay. The oard of the Torquay Company, appre- ating the circumstances, wisely deter- ined on a policy which has developed Vorks of pleasing design and technical fficiency, particularly in regard to dust xtraction and smoke elimination.

Surrounding the Works is a developing esidential area, and from the photographs Appendix 1 it will be seen that full dvantage of natural surroundings has een taken, and augmented by the plant- ng of trees and shrubs, some of which are nmediately adjacent to the sulphur emoval installations.

. The Two Smokeless Products of Carbonization

Whilst the point has been made and ublished many times previously, I take he liberty of emphasizing that the process of carbonization in an efficient manner in itself produces two smokeless fuels. The use of both these fuels reduces the wasteful and smoke producing burning of raw coals. The mechanism of burning solid fuel efficiently is related to its reactivity, this being closely allied to its porous structure. The distilling of coal produces a reactive smokeless residual fuel, that from vertical retorts being even more reactive than coke from horizontal or chamber ovens.

6. Process Problems Relating to Smoke Abatement :

For clean operation the problems arising in gas manufacture are related to :

(*a*) The handling and storage of coal and coke.

(*b*) Processing through the distilling plant with complete collection of all gaseous products and dust arising in the process.

(*c*) The removal of ammonia and tar.

(*d*) The operation of plant for the extraction of sulphur from gas and the prevention of pollution arising during the process.

(*e*) The removal of fine grits arising from accelerated gasification of coke in carburetted water gas plants.

(*f*) The control and operation of high efficiency boilers using low grade smokeless fuel.

(*g*) The disposal of ash.

(*h*) The elimination of clouds of vapour to obviate its attendant corrosive effect, particularly when it is in proximity of possible sulphurous gases.

(*i*) General cleanliness and Works layout to prevent incidental dust.

(*j*) Utilization or disposal of all collected dusts.

7-14. Elaboration of Methods Employed :

7. Methods employed at the Torquay Works to deal with these problems include mechanical plant comprising the cyclone, centrifuge, and filtration types, and also electrical precipitation plant for application to problems involving collection of fine particles.

The coal processed is largely washed Yorkshire Doubles and is brought to the receiving hopper by rail. It is discharged by means of a side tippler. During this process a very fine water spray is used to reduce incidental dust, and coal conveyed by the telpher to storage is discharged with the telpher grab in the lowest possible position. The coal cellars have dividing

APPENDIX I : Torquay Gas Works

(*Top*) *General View of Works*, (*Bottom*) *Sulphur Removal Plant*

walls which reduce dust nuisance during high winds. The conveyor from the coal receiving hopper to the retort house is totally enclosed and the coal hoppers in the roof of the retort house are also completely enclosed and segregated from the retort house building.

8. The coal flows by gravity from the bunkers into the retorts to be extracted after carbonization, as coke which is cooled by steam and entrained water immediately before discharge. At the point of discharge an enclosing suction hood is arranged connected to a Visco Beth extraction plant which effectively collects all the fine dust normally incidental with the discharging of the coke into the conveyor. The principle of operation of this induced draught plant is filtration rather than settlement, the filtering medium being in the form of woollen fabric cylinders positioned vertically through which the extracted fumes and dust are passed. Banks of these "socks" are used in turn, while others are mechanically shaken to release the very fine collected material which falls into hoppers below, from which it is collected by screw conveyor prior to bagging. This equipment is capable of more efficient removal of dust than a cyclone, particularly as the dust particles are very small, 60 per cent. being less than 14 microns. However, as the induced draught is created by a large capacity fan, the operational charges are greater than by cyclone extraction.

The producer gas of low calorific value used to heat distillation settings is generated in plant so designed that very low gas velocities are employed, and almost all the entrained solid material is effectively collected in the lambent flow through the setting, to be removed periodically in conjunction with routine operation. A further step in this particular field is the trend to install mechanically-operated producers, complete with cyclones, for the removal of solid material. In some installations washing of the producer gas is effected, but in all cases absence of "fliers" in the waste gases is assured.

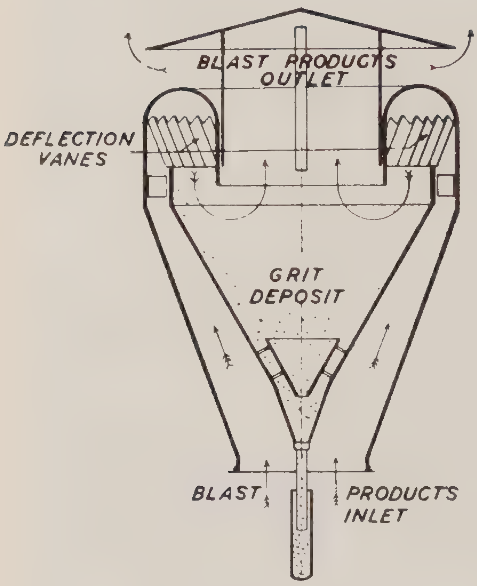
9. All gaseous products of the carbonization process are collected, passed through condensers, electrostatic tar precipitators, and ammonia washing plants, where the solubility of ammonia in water makes the process simple and effective.

The gas then is further treated to remove the sulphur, two processes being used which are enclosed and fumeless. Hydrogen sulphide is removed by passing the gas through beds of ferric oxide and the cycle of operation so arranged that when the oxide bed has to be replaced it is at that time in a state where the hydrogen sulphide is chemically absorbed and no sulphur fumes are emitted. Further extraction of sulphur compounds is carried out in oil washing plants which by the same process extract valuable benzole entrained in the gas as manufactured.

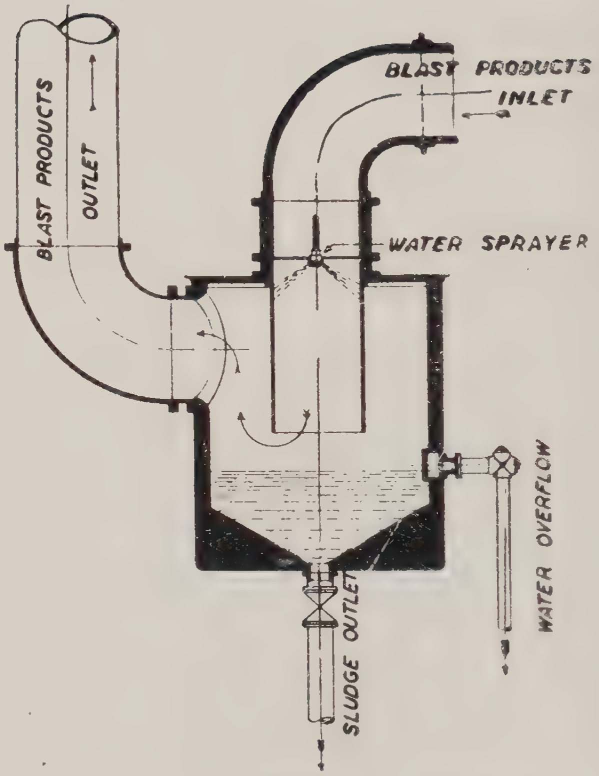
10. It will be appreciated that the physical condition, in respect of size of any fuel, has a great bearing on dust emission where high rates of burning and/or high flue gas velocities are employed. With this in view, fine coke to boilers, although of low grade is dedusted. Similarly fuel to the carburetted water gas plant is screened and dedusted to ensure the absolute minimum material likely to be entrained from the fuel bed by the very high velocities of air blast employed. In addition, cyclone type dust extractors are fitted to waste gas stacks of boiler and C.W.G. Plants. Line diagrams showing Grit Catchers and Blast Products Washer, the latter being usually used in connection with blue water gas plants, are shown in Appendix II. The wet process has the advantage of collecting the dust as sludge, preventing the tendency for it to be blown about in subsequent handling. An interesting addition to the solid fuel boiler installation is the inclusion of dust collecting pockets at points on the boiler and horizontal flues. Thus, instead of the flues accommodating dust collections until equilibrium is reached between the prevailing velocity and dust settlement, the whole flue installation operates as a grit collector in addition to the cyclone extractor.

11. Special attention is given to the removal of ash in the various clinkering processes, that from boilers being immediately damped down before storage. This amount of clinker is, however, small compared with that taken from the producers of the carbonizing and the carburetted water gas plants. In the case of the Retort House, the clinker is removed whilst saturated with water from the foot of the step grate producer. The extraction of clinker from the C.W.G. Plant is automatic and through a water seal, but in both cases, handling from the plant to the disposal points is mechanical and enclosed. Facilities exist for screening the ashes, the fines being sold for block making and the large clinker to local builders for paths, etc.

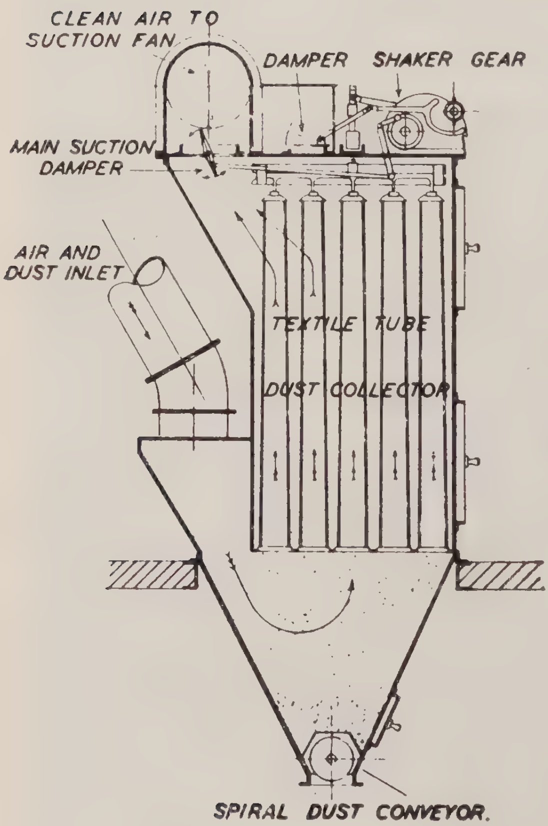
APPENDIX II



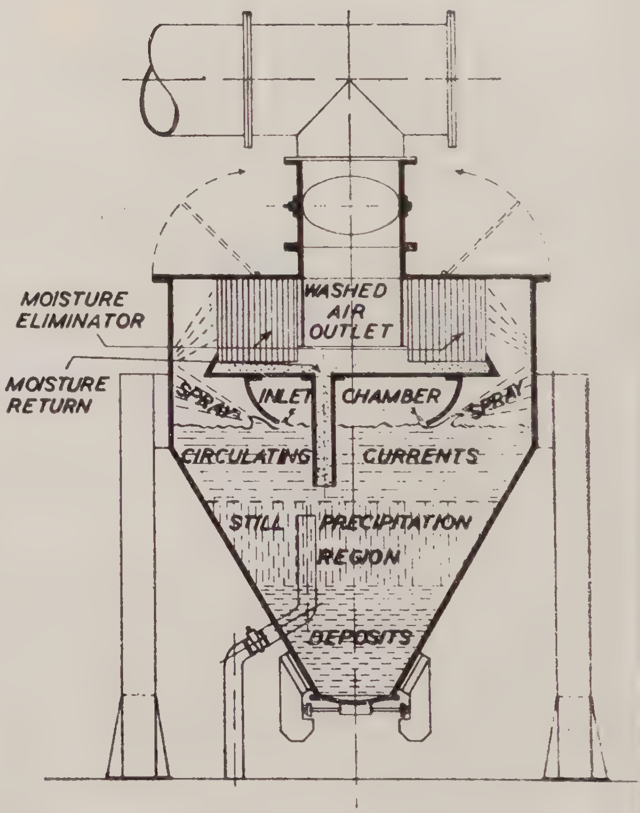
CENTRIFLOVANE
GRIT CATCHER.



BLAST PRODUCTS WASHER.



VISCO-BETH DUST PLANT.



DRUMMOND SEPARATION PLANT.

12. Vapour caused by steam exhausts is entirely eliminated by the grouping of all steam plant and the collection and subsequent use of exhaust steam. Small driving units located throughout the Works are electrically powered from the steam-driven generators. Steam is raised in waste heat boilers which are integral parts of the coal gas plant and the Carburetted Water Gas Plant, but solid fuel boilers are used to balance requirements as dictated by the incidence of loads. Some exhaust steam is used for process work and for steaming the coal charges during carbonization, whilst the balance is passed through heat exchangers which supply hot water for heating Works buildings and adjacent offices.

By the special attention thus given to reduce local humidity, unsightly vapour trails are removed and the deleterious effect on surrounding steelwork prevented.

13. Having dealt with the steps taken to reduce nuisance as far as practicable at source, I would draw attention to the general Works layout. All plants handling coal, coke or oxide are enclosed and occasional dust is collected by industrial vacuum cleaning plants, the exhausting units being permanently sited, each in its own house, and the buildings served by a pipe network. This method of cleaning is well known and the advantages universally appreciated. Roads and storage yards are of concrete which, graded to drains, permits regular and effective hosing. Open spaces scheduled for plant extensions are turfed or planted with shrubs. Trees have been added around the boundaries of the Works as a screen.

14. Appendix III gives an analysis of the disposal and collection of the total sulphur present in the coal annually processed. It will be noted that the percentage sulphur emitted at Works is just over 10 per cent. of the total sulphur content of the coal. Processing, as we do, coal having a sulphur content of 1.5 per cent. this represents a total of 110 tons per annum emitted at Works arising from the carbonization of 73,000 tons of coal or less than 0.2 per cent.

The amount of fine carbon dust collected from coal handling, coke extraction and C.W.G. Plants is approximately 100 tons per annum and this, along with fine coke from dedusting screens, is briquetted with a 10 per cent. admixture of pitch and used after carbonizing to augment fuel to boilers or producers.

15. Indication of Effect of Measures :

Tests on soil conditions in the Works show a good lime status with an average Ph value of 7.3 and it may be of interest to note that growths of test vegetable specimens in flower beds and allotments adjacent to the carbonizing and boiler plants have compared reasonably with those obtained by a local market gardener.

Normally no tests are carried out to examine deposits around the Torquay Works, but in the very short time during the preparation of these notes, petri dish tests have been made to give some indications of the effectiveness of the measures applied. The tests were taken at 13 points located within the Works or on the perimeter and were obtained over a period of 14 days (fortunately dry). It will readily be appreciated that errors in collection and testing preclude these tests being comparative with the published analyses of deposit gauge tests carefully taken over prolonged periods, but I submit them as some indication of the conditions prevailing. The daily average deposit taken at points throughout the whole Works was 559 grams per 100 square metres per month. This figure includes results obtained on the shunting sidings, engine room roof, railway line and near to the coal store which in themselves give a daily average of 1,220 grams per 100 square metres, and in the case of the shunting sidings alone a result of 1,837 grams per 100 square metres. The average deposit, omitting these points, for the remainder of the Works is 147 grams per 100 square metres. It is not within the scope of this Paper to give detailed information and attention is drawn to a Paper by Wiseman which gives valuable technical information (iii).

16. Value and Costs :

The value of cleanliness on any Works, above the most important factor which is the absence of nuisance around the Station, is difficult to assess. The measures I have illustrated, apart from capital charges of the installations, which amount to less than 2 per cent. of the total capital involved, cost no more to operate than the less effective sweeping brush. Removal at source by mechanical means is of paramount importance and in Appendix IV are given figures showing the cost of the plants used in relation to the total cost of the installation carrying out the process involved. These figures speak for themselves but we cannot overlook the advantage enjoyed by all operatives by their working in comparatively dust-free air. The retort houses are fitted with cold air douche plants which assist ventilation on

each working platform and reduce the large, uncontrolled and dust carrying convection currents usually obtaining in high buildings containing plant operating at high temperatures.

17. Conclusion :

Research under the auspices of the Gas Council continues in close co-operation with the Contractors who supply equipment for the Industry, attention being particularly directed towards improved methods of sulphur removal by liquid extraction and continuous flow ferric oxide treatment.

It is fully realized that less strongly coking coals are more readily available for carbonization and great improvements have been made in intermittent vertical retort plants, designed for processing these coals. In modern plants, the attendant dust and smoke, previously arising during the charging process, is collected by suction plants which effectively prevent pollution.

It is hoped that these notes will indicate that by sound planning of installations and efficient operation the Gas Industry is making a determined effort towards the elimination of smoke nuisance and I wish to thank the Society for the opportunity afforded to indicate the Industry's wholehearted co-operation.

May I also record my thanks to the Chairman of the South Western Gas Board for his permission to present this Paper.

References

(i) " Plan For Coal." National Coal Board, October, 1950. Technical Appendix Table III, Page 53.

(ii) *Parker.* " Cities without Smoke," paper to Royal Society of Arts, November 22nd, 1950.

(iii) *Wiseman.* " Dust Problems in Gasworks Practice." Paper to the London and Southern Junior Gas Association, March 11th, 1949.

APPENDIX III : THE OCCURRENCE OF SULPHUR IN HOLLACOMBE WORKS GAS COALS AND ITS DISTRIBUTION IN THE PRODUCTS OF DISTILLATION

Product	*Quantity for 1950*	*Sulphur Content*	*Sulphur admitted to atmosphere at Works*	*Sulphur removed or retained at Works*	*Sulphur distributed in smokeless fuels*	*Totals*
Coal Processed (tons) ..	73,000	1,030	—	—	—	1,030
Coal Gas (10^6 therms) ..	635	442	Nil	433	9	442
Coke (tons)	33,000	365	Nil	Nil	365	365
Coke used at Works (tons) ..	15,200	165	110	55	Nil	165
Tar (10^3 glns.)	1,170	Negligible	Nil	Negligible	Nil	Negligible
Ammoniacal Liquor ..	—	58	Negligible	58	Nil	58
		Totals ..	110	546	374	1,030
		Expressed as % ..	10.7	53.0	36.3	100

APPENDIX IV : CAPITAL COSTS

Main Plant	*Capital Cost of Main Plant*	*Capital Costs*		*%'s of Total*		*%'s of total of dust removal equipment*
		Vacuum Cleaning Plant	*Dust Extraction Plant*	*Vacuum Cleaning Plant*	*Dust Extraction Plant*	
Large Vertical Retort House in South West	£880,000	£3,750	£6,000	0.426	0.682	1.318
Large Coke Grading Plant in South West..	£125,000	£3,500		2.800		
Medium Vertical Retort House in South West	£116,500 (Approx.)	£1,080	£1,975	0.927	1.695	1.694
Medium C.W.G. Plant in South West ..	£123,500 (Approx.)	£1,010		0.818		

(3) ELECTRICITY

The Minimization of Atmospheric Pollution from Power Stations

by

Dr. H. E. Crossley

It is generally recognized that the British Electricity Authority gives considerable help in the minimization of atmospheric pollution by providing electricity for power, space heating, water heating, and lighting. In all these cases nothing is contributed to the atmosphere, and the alternative with appliances fired by solid fuel would be the emission of sulphur gases and soot at low levels. Soot, the main cause of dirty buildings and dirty fabrics, is not emitted from power stations.

In this country the production of electricity by water power is necessarily very limited, and we have to depend mainly on the burning of coal in boilers, to supply steam to turbo-generators. Atmospheric pollution is inevitable from the boiler plant, and the short-term and long-term policies of the Authority are to minimize this pollution by all practicable means. This report has been prepared to indicate in simple terms how these policies have been put into action.

Training and Research

The efficiency of a boiler plant is directly linked with the pollution emitted from that boiler, if the boiler was inexpertly operated it would emit more pollution, particularly smoke and grit. All the power stations of the B.E.A are staffed by skilled engineers, with considerable experience in the operation of boilers, and these engineers are helped by specialists of various kinds within the organization. Every boiler is operated to get the best conditions possible, and the limitations are mainly the low grade quality of the coal which has to be burnt in the national interest, and the shortage of plant. Courses of instruction are given by the Authority to all grades of employees, and every effort is made to ensure that the present high standard of operation will be maintained in the future, and even improved.

Investigations and research concerned with the minimization of atmospheric pollution are carried out in all 14 Divisions of the Authority, and by the Research Department at Headquarters. An example of the success of this effort will be found in the section concerned with the emission of water droplets from cooling towers. In addition to these investigations the Authority collaborates fully in the investigation of atmospheric pollution by the Atmospheric Pollution Research Committee of the Department of Scientific and Industrial Research. Measurements of pollution are made by the Power Station staffs, and facilities are provided to the D.S.I.R. for surveys of specific areas.

Types of Atmospheric Pollution from Power Stations

As stated at the beginning of this report soot is not emitted from power stations. In some cases nuisance has been caused by water droplets coming from cooling towers, but more generally emission is concerned with sulphur gases and grit.

Water droplets

Precipitation from cooling towers, which some people have noticed more especially at times of peak load, will be ended as a result of research carried out by the Authority's Research Laboratories. It was evident that the solution of the problem would be an internal modification of cooling towers, and after trials of over fifty different schemes the answer was found. This is a system of louvres (eliminators), which trap the water droplets very soon after they have been picked up by the rising current of air within the tower.

A programme has been prepared for modifying all cooling towers which have been the subject of complaint, and all new towers constructed in built-up areas will be fitted with eliminators.

Sulphur Gases

The problem of pollution by sulphur gases is common to all plants and appliances which burn solid or liquid fuels. Before Battersea and Fulham Power Stations were built there was considerable apprehension about the contribution they would make to the pollution of the atmosphere in London by sulphur gases, and it was made compulsory for these stations to be equipped with gas purification plant to remove practically all the sulphur gases from the flue gases.

Almost complete purification has still not been carried out at any other power station in the world, but it was accomplished at Battersea and Fulham. The processes were different, and in each case a high degree of gas purification was maintained. Even then these processes were extremely costly, in spite of the fact that they burnt selected coals containing only 0.8 to 1.0 per cent of sulphur (about half the average amount of sulphur in power station coals). The capital cost of the gas purification plant for the first part of Battersea Power Station, for example, was approximately £250,000 and the operation of the plant cost 2s. 6d. for each ton of coal burnt, the average weekly tonnage being about 11,000. These costs would be more than quadrupled with present-day conditions, and would be still further increased with fuels of higher sulphur content. The Fulham process presented considerable difficulties in operations and was even more costly than the Battersea process.

The Battersea process was relatively simple in operation, but it could only be applied on a river as big as the Thames. Even so difficulties could arise due to the low solubility of the effluent (calcium sulphate) in water. If the process were to be applied at more than two power stations on the Thames, the river would be super-saturated with calcium sulphate.

The biggest objection to gas purification however, is that it has so far been done only by washing the gases. This necessarily chills the gases and on many days the chilled gases fall rapidly on leaving the chimney. In this way although only a little sulphur is left in the gas, this is frequently carried down to ground levels. Considering its own observations and published information on the amount of atmospheric pollution in districts near Battersea and Fulham Power Stations, the Authority believe that the benefit near these two stations has been derived from the high chimneys rather than from the expensive washing processes, as the pollution measurements showed no appreciable change comparing pre-war years with war years. During the war the station carried a higher load than ever before and the washing plant was shut down for security reasons, as it caused the emission of a white plume clearly marking the site. An official survey of the atmospheric pollution of these districts has been made by the D.S.I.R. for all the years in question, and it is understood that the results will be published shortly. The Authority will consider these results very carefully, and also the results of similar surveys being carried out by D.S.I.R. round sites before and after the erection of power stations, and it is the present belief that these result will show that high chimneys are a satisfactory safeguard. In the bigger power stations chimney gases are emitted at heights of 300 ft. to 350 ft. above the surrounding district, contrasting with the domestic chimney emission at one-tenth of those heights.

Grit.

Big boilers are operated by forced draught which carried particles of ash from the fuel bed, suspended in the flue gases. If nothing was done to prevent it, this ash would be carried out of the chimneys, and the coarse particles would be deposited on the surrounding districts. This is well-known, and it has given rise to an unfortunate tendency to attribute grit pollution wholly to the nearest power station. In some of these cases the grit has come mainly from sources other than the power station, for example, in one case the grit was almost wholly sea sand carried by a gale, and in another case it came from the demolition of buildings. In every industrial district the grit pollution comes from a large number of sources, including central heating plants, road dust, locomotives, and in country districts winds carry soil minerals from tilled ground, particularly from light soils.

Some of the oldest power stations have never had any satisfactory means of removing the grit from the chimney gases, and they have given rise to local nuisance. These stations, however, operate for only a limited period each day, and they will be shut down completely as soon as the plant capacity of the Authority is raised to a satisfactory total. For this reason, and also because the output of the manufacturers is all required for the new power stations, it would be wrong to adopt the policy of fitting grit arresters to these very old plants.

The newer power stations are all equipped with efficient grit arresters and design is constantly being improved. Boilers having travelling grate stokers are generally equipped with multi-cyclone mechanical grit collectors which are much more efficient than any type of arrester previously used for such plant. Pulverized fuel fired boilers are equipped with electro-static precipitators which are specially suitable for trapping the very fine ash particles that result from the coal having been pulverized before burning.

Many members of the staff of the Authority are studying the efficiency of grit arresters, and further groups within the organization are investing combustion conditions to find ways of ensuring that the carry-over of grit from the furnaces is reduced to a minimum.

Summary

The British Electricity Authority believes that its prime duty, supplying electricity to the nation, is a very big contribution to the minimization of atmospheric pollution. It is a public body, and consequently it is making every effort to ensure that present pollution of the atmosphere from Power Stations is no more than can be avoided, and that the future pollution from these sources will be the lowest that can be attained. Over the next few years the average rate of expenditure by the B.E.A. on measures for avoiding pollution from Power Stations will be about £4 million per annum. The Authority is very pleased to co-operate with official investigations of atmospheric pollution and particularly pleased to have the opportunity of presenting this paper to the Smoke Abatement Society.

(4) IRON AND STEEL MANUFACTURE

by

Neil H. Turner

Iron and steel works have been in the past, and some still remain today to a degree, great culprits with regard to smoke emission and discharge of dust and grit into the atmosphere.

Originally coal was cheap and the attention paid to its utilization left much to be desired ; abundant smoke emission was the inevitable result. The desire to improve general working conditions, the need for economy and the necessity of conservation of fuel have led to a substantial elimination of this trouble. In some cases, however, it is essential for the steelmaking operation to be carried out in a reducing atmosphere, and where coal is used as fuel, smoke emission is almost inevitable. With the exception of such special cases and of steam locos and cranes smoke nuisance due to incomplete combustion is nearly a thing of the past, particularly so far as the large iron and steel works are concerned.

The progress towards the elimination of dust and grit emission has been much slower, but during the last decade, under the influence of enlightened management a strong campaign has been carried out to eliminate this evil. On this subject it may be appropriate to quote from a talk given in 1941 by one of the leaders of the industry, Sir Walter Benton Jones, to the officers of the United Steel Companies :

> " We live in our works, and if we want to make the best use of them, the first thing we have to do is make them fit not only to work in but to live in ; fit to live in for ourselves ; fit to live in for everyone who finds occupation there . . . . The big things we need where we are to live are light, air, heating, cleanliness and tidiness."

As a result of this campaign, measures are now taken as a matter of course in some of the iron and steel works to prevent dust reaching the atmosphere. There is, however, still a long way to go before conditions are fully satisfactory and it is the purpose of this paper to review briefly what the problems are and how they are being tackled.

As iron and steel works may cover very large areas, and comprise many sections, each responsible to a different degree, and from different causes, for contamination of the atmosphere, it is considered best to examine separately each of these sections, the remarks passed being generally based on the practice at the Appleby-Frodingham Steel Works.

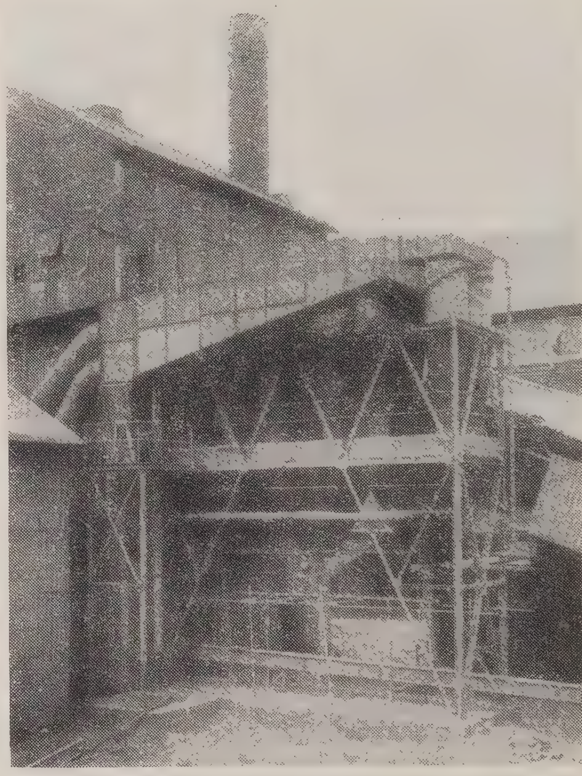
1. Iron Making

Blast furnaces are temperamental and show their temperament by occasional erratic operation, the degree of erratic working being strongly influenced by the quality of the material going into the furnace. In other words, a blast furnace charged with low grade ore is more likely to behave badly and will more frequently discharge clouds of dust into the atmosphere. The discharge takes place through the safety releases provided to avoid dangerous rises of pressure. It would not, therefore, be logical to

interpose some equipment designed to remove the suspended matter from this discharge. Either the equipment would introduce too much extra resistance when catering for the worse cases, or it would have to be designed so generously that it would be ineffective most of the time.

Cyclone for Dust Extraction at outlet of Rotary Ore Dryer

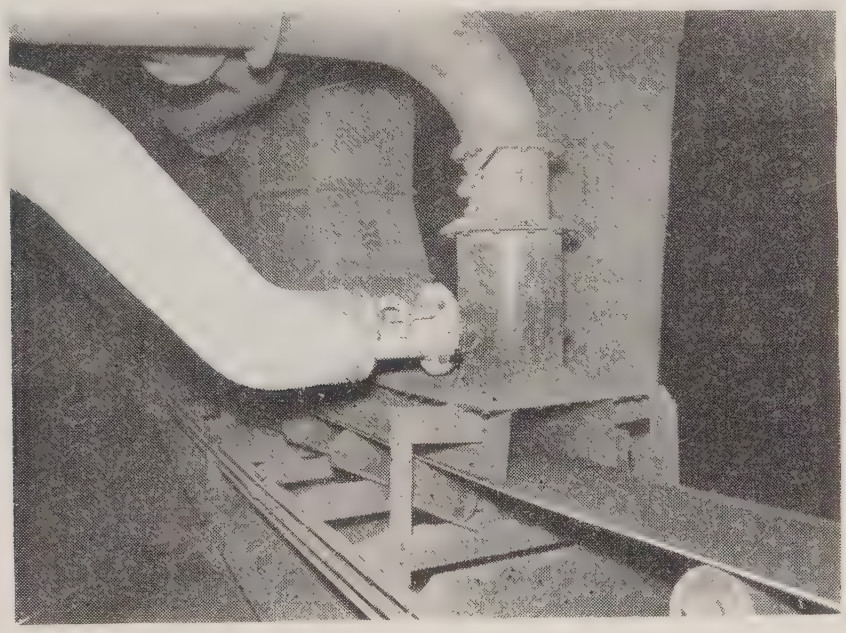
The solution to the problem of preventing pollution of the atmosphere through this cause must be looked for in a different direction, e.g., reduce and possibly eliminate the reason for bad behaviour by feeding the blast furnaces with suitable material. In the case of blast furnaces operating on low grade ore, this calls for " ore preparation," i.e., sorting and crushing the ore to regular size and screening the fines. These operations carry with them the potentiality of more discharge of dust and grit, unless provision is made to catch these by the use of properly disposed hoods and cyclones. This is not as simple as it may appear and much thought and money may have to be spent before satisfactory results are achieved. For instance, at the Appleby-Frodingham Steel Works, much trouble was experienced with the delayed effect of moisture in the dust concerned which had not been foreseen by the supplier of the dust elimination plant. It was only after thorough investigations by the works specialized personnel that an effective remedy was introduced. Extensions to this particular ore preparation plant which have just been put into operation include a very elaborate dust collecting equipment, but this time provided from the start with the means of avoiding the initial trouble.



Cyclone at Sinter Plant Screen House

Besides obviating the effects of abnormal behaviour of the blast furnaces, it is also necessary to take precautions to dispose of the dust which may be released by occasional lack of balance between production and utilization of the blast furnace gas. This is particularly in evidence at the week-end when such parts of the works as the rolling mills are inoperative. When the whole plant is somewhat balanced, that is, when the by-product gases supply almost the whole of the fuel requirements, a fair amount of iron and steel plant. Potentialities of dust and grit emission there are multiple and the following are representative :

Charging of the ovens with the prepared coal used to be done from a hopper without special precautions, and clouds of smoke and dust were generally the result. This nuisance has now been greatly reduced, but not completely eliminated, by creating a momentary suction in the oven at the time of charging. In varying degrees this is now standard practice.



Hood for Dust Extraction from Conveyor Belt to Sinter Plant

blast furnace gas has to be bled at the week-end as its calorific value is such that it could not be stored economically. It was previously the practice to bleed this gas at the furnace, that is, accompanied by the dust it carries as raw gas. Nowadays the bleeding takes place at the gas cleaning plant after the bulk of the dust has been removed. Appreciable cost is involved in this practice depending on the type of gas cleaning plant used.

While what precedes shows that care is taken to eliminate the major cause of dust discharge from the blast furnaces, particular cases of badly fitting bleeder valves, leaky furnace joints, etc., are still occasional causes of dust emission, and while it is too optimistic to expect these troubles to be eradicated at one stroke, progress is continual.

2. Coke Making

Coke making comes into consideration when Coke Ovens are incorporated in the

The discharge of the coke from the ovens may be accompanied by smoke emission when the carbonization has not been fully completed, but will definitely be accompanied by dust and grit emission due to the breaking of the coke, and the effect is aggravated by the rising column of hot air. The remedy to the first occurrence is in the hands of the Coke Ovens operator, but to deal with the second, a radical change of design of the coke car will be required.

Wet quenching of the coke transfers the sensible heat of the coke to the water. To collect the hot and wet suspended matter which, intermittently for a period of approximately one minute, is entrained by the large amount of steam generated, is impracticable. From this angle dry quenching is the solution, but dry quenching by itself causes a greater amount of dust. This dust would, however, be in a suitable condition to be

taken care of by cyclones, but the cost of providing the latter equipment in addition to the already very high cost of a dry quenching installation is a heavy impediment.

Before being delivered to the blast furnaces, the coke has to be screened with inevitable liberation of large amounts of dust, but the prevention of the escape of this dust to the atmosphere presents no particular difficulties, and it is interesting to note that the extensions to the Coke Oven Plant at the Appleby-Frodingham Steel Works include the provision of the necessary equipment.

3. Steel Making

Originally steel furnaces were fired by Producer gas, and a large percentage of the dust and smoke emission came from the gas producer plant and gas mains. Ill-fitting producer tops and dust catcher valves allowed considerable leakage of raw gas. By better attention and full realization of the fuel economies that ensue, this source of pollution has now been mostly eliminated.

Raw gas usage as is the practice in ordinary steel making leads to the gas mains soon getting choked with a tar and soot deposit which has to be removed at regular intervals. While in the past this cleaning was done very crudely, the necessity to maintain cleaner surroundings has led to the use of better methods and better equipment, such as, for instance, permanently fixed soot blowers built into the gas main which allow the soot and tarry matter collected to be burned before discharge at the chimney top. No doubt very fine fly ash still finds its way into the atmosphere, but on the whole the elimination of the thick smoke which was a feature of the old method has warranted the change.

In an integrated plant where blast furnace gas and coke oven gas are available, the gas producers have generally been discarded and their contribution to the dust problem has been eliminated in that manner. Elsewhere there has been lately a strong tendency towards substitution of oil or pitch-creosote firing for producer gas. Trouble with incomplete combustion is generally not encountered as the high temperature required in melting furnaces necessitates good control of combustion. Furthermore, before the waste gases reach the chimney and pass into the atmosphere they are taken through regenerators to recover some of their heat and through long flues which tend to eliminate any residual suspended matter resulting from the direct combustion of the oil or pitch-creosote mixture.

There is, however, an indirect effect of the combustion of liquid fuel, particularly pitch-creosote mixture. According to some authorities, the reaction between it and the steel, mainly while melting scrap, causes the formation of iron carbonyl, which soon breaks down into finely divided iron oxide which either separates from the waste gases in the regenerators or flues, or is discharged from the chimney in the form of a cloud of fine light brown smoke. The true cause of the reaction is still not fully understood and the problem of the elimination of its effect is at present being investigated. The use of oxygen to accelerate the working of the charge in steel furnaces will tend to increase this type of dust emission. The procedure is somewhat new and the investigations which are afoot to prevent what is also a loss to steelmaking have gone so far as to suggest the washing of the waste gases as a solution, but no practicable method has yet been devised.

To mention the steel furnaces and the gas producers as the only potential dust sources in steelmaking would not be fair as a large quantity of dust can arise from ancillary plants, such as, in the case of basic steel production, the crushing of the burned dolomite used for fettling the furnaces. At one time, this process, which can only be carried out dry gave rise to large clouds of greyish-white dust freely discharged. Today in a modern works, a vacuum extraction plant complete with filters minimises this nuisance. The introduction of mechanical fettling and the use of containers to feed direct into the fettling machines are further improvements, bringing a cleaner atmosphere in their train.

4. Steel Rolling

The creation of dust during rolling only arises where the finishing rolling temperatures are low due to high cooling rates. This is the case when rolling material of which the surface area is large relative to the weight, as for instance plates. The iron oxide which is bound to be formed during the rolling process breaks down to a dust due to the high rolling pressure necessary, and the air currents caused by the difference of temperature tend to disperse this dust in the atmosphere. Provided an extraction system is arranged for over the mill and the air stream is ultimately washed, this dust need not be a nuisance. Such equipment exists in the

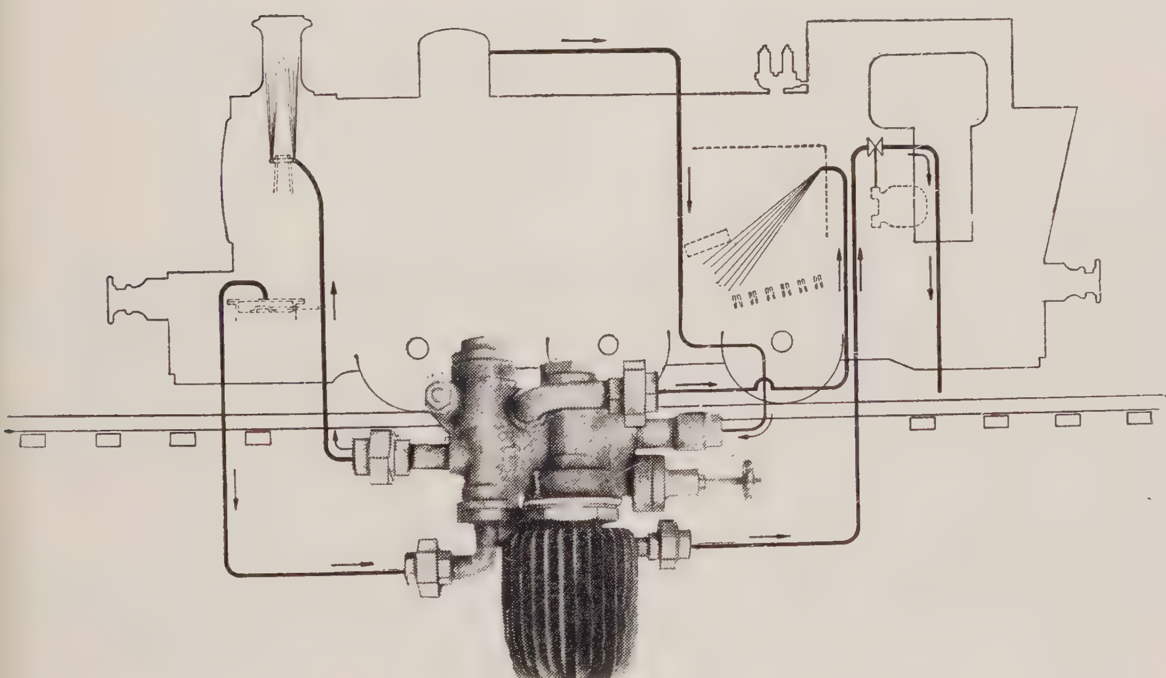
Container for Ash Removal from Water Tube Boiler

Appleby-Frodingham Steel Works.

Associated with steel rolling are the steel heating furnaces. In an integrated plant they will be fired with some of the by-product gases, and thus will be smoke-free. In other works where such gases are not available, coal-fired furnaces still remain, sometimes hand-fired, and at times emit black smoke. The Fuel Efficiency Campaign undertaken by the Industry and the Ministry of Fuel and Power is bearing fruit and the ordinary hand-fired furnace is gradually being replaced by stoker-fired or by gas-fired furnaces and improved combustion.

5. Steam Generation

Although integrated iron and steel works have for a long time made use of their by-product gases for steam generation and were thus free from trouble due to incomplete combustion, there are still here and there boilers using dirty blast furnace gas. The majority of plants, however, clean the gas required for boiler use. This change has been accelerated by the tendency to replace Lancashire boilers by large water tube boilers fitted generally with automatic combustion control. There are, however, still occasions when, due to the boilers acting as buffers to take care of a momen-



ARRANGEMENT OF SMOKE CONSUMING DEVICE FOR WORKS SHUNTING LOCOMOTIVES.

tary out-of-balance state between gas production and consumption, reversion has to be made to such fuels as coal, oil or pitch-creosote mixture. During the change-over, there is the potentiality of temporary smoke emission due to the necessity of building the coal bed quickly to full steaming capacity or due to inaccuracies in the setting of the liquid fuel/air ratio. The remedy is largely in the hands of the boiler minder, and when he fails in his duty, his attention is generally quickly drawn by the personnel in charge of fuel control, if not directly by smoke detector equipment.

In those steel works where by-product gases are not available, the trend has been towards making full use of the waste heat available and in this manner eliminate the potentialities of smoke production.

6. Traffic

Steam locos and steam cranes are the worst offenders with regard to smoke emission, and here again the human element is an important factor.

Balancing the firing rate with the constantly variable loads to be dealt with is not easy. There is, therefore, a tendency to feed an excessive amount of coal at one time and so provide an adequate fuel bed reserve to take care of the possible next requirement. No amount of planning would provide the remedy and it is necessary to tackle the problem from other angles.

Smoke consuming devices have been tried and found successful to a fair degree as far as decreasing the smoke emission, but rather costly in fuel consumption. A modified type is at present being tried at the Appleby-Frodingham Steel Works, and it is hoped that the modification made will permit its more economical use.

Another solution is the substitution of diesel for steam-operated locos and cranes. The improvement in quality of mechanical maintenance which has gradually taken place in iron and steel works will permit more use being made of the internal combustion engine. Several works are making extensive trials with this type of locomotive and if they prove successful, a long-term programme of replacement will undoubtedly be put into operation.

Conclusion

The necessity of preventing atmospheric pollution is presenting the Iron and Steel Industry with many varied problems, the solution to some of which is not simple.

(5) IN CEMENT MANUFACTURE

by

E. Burke, M.SC., A.M.I.C.E., A.C.G.I., D.I.C.

The problem of smoke abatement in the cement industry has been a very small one in recent years due to the very high efficiency of combustion which is always maintained. The only time when there is difficulty is during the period of lighting up the kilns and until a reasonable temperature is obtained. This may be a matter of some half an hour or so. As cement kilns are run as continuously as possible these periods form an insignificant fraction of the running time. " Black smoking " outside the period of lighting up is a heinous crime in the cement industry.

A few words on the process of manufacture may not be out of place at this stage.

The raw materials, consisting of chalk and clay or limestone and shale, are ground with water to give a slip or " slurry " of about the consistency of cream. This is introduced at the feed end of the rotary kiln which is substantially a steel cylinder 300 to 500 feet long and 8 to 10 feet in diameter lined with refractory bricks. The kiln is inclined slightly downwards away from the feed end and is rotated at about one revolution per minute. At the lower end pulverized coal is blown in through a burner pipe and its combustion in the kiln provides the heat for the chemical reactions required for the process. Fig. 1 shows a diagram of the process.

The slurry passes slowly down the kiln being first dried and then gradually raised to a temperature of 1400 to 1450°C. in the hottest portion known as the burning zone. On emergence from the

burning zone the slurry has been converted to clinker which consists of sintered nodules. From the kiln the clinker passes to a cooler and is afterwards ground in tube mills with a small proportion of gypsum to give what we know as Portland cement.

The kiln at the feed end is provided with a system of chains the object of which is to improve the exchange of heat between the slurry and the combustion gases.

In the course of its travel down the kiln the carbon dioxide present in the calcium carbonate in the slurry is driven off and mixed with the combustion gases. In addition the large amount of water present in the slurry is also driven off and mixes with the combustion gases. The condensation of this water as the gases emerge from the chimney forms the familiar plume which is so characteristic of a cement works in England and which is wrongly referred to as " smoke. "

The reason for the high efficiency of combustion which results in the elimination of smoke is not far to seek. The three main factors are :

(1) Hot air for combustion.

(2) Very high combustion chamber temperature (1400-1450°C. in the burning zone).

(3) Very large combustion chamber.

These items will be dealt with individually.

1. When the clinker emerges from the kiln it passes through a rotary cooler through which the air for combustion is drawn. This hot air increases the efficiency of combustion and of the whole thermal process.

2. The high burning zone temperature enables a very rapid ignition of the pulverized coal due to the high speed of liberation of volatile matter.

3. The combustion chamber of the kiln can be considered to have very nearly the same volume as the kiln. It may be seen, therefore, that the ratio of combustion chamber volume to rate of burning coal is enormous. Thus the coal has plenty of time and opportunity to burn completely. This will be appreciated when it can be said that the normal exit gases from a cement kiln contain 1 to 2 per cent. oxygen and 0.1 to 0.2 per cent. carbon monoxide.

About two-thirds of the ash from the coal is intercepted by the clinker in the kiln or by the slurry near the feed end where the chains are placed. The other one-third is dealt with in the de-dusting equipment.

It may be seen, therefore, that problems of smoke abatement are of little moment.

A more difficult problem in the cement industry has been the reduction of dust emission from the chimney. This dust is created mostly by the tumbling of the raw material in the kiln. A good proportion of this dust, which consists mostly of chalk and clay, is arrested in the curtains of chains near the feed end of the kiln. The dust that escapes these curtains is dealt with in de-dusting equipment.

There are various methods of removing dust from the combustion gases, the oldest being by passing them to a dust chamber where the velocity of the gases is reduced and a part of the dust settles out. The modern method, however, is to remove the dust either by means of a cyclone or by electrical precipitation.

A good deal of development is being carried out by manufacturers of cyclones and electrical precipitators with a view to improving their efficiency. Up to the present the electrical precipitator has proved to be the most efficient and can remove 96 to 97 per cent of the dust in the combustion gases. On account of its high efficiency it is the type of equip-

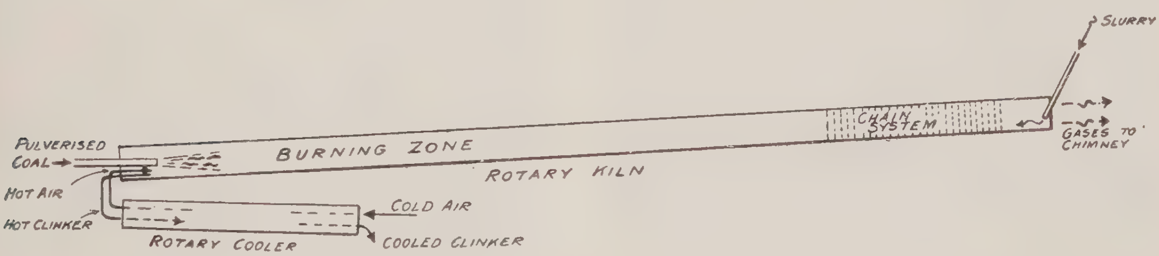


DIAGRAM OF ROTARY CEMENT KILN & COOLER
FIG. 1.

ment most favoured in the cement industry.

Cement works are under the scrutiny of the Chief Inspector Alkali, etc., Works who carries out his inspections through regional officers. A serious difficulty which had been in existence for a long period was the difficulty of measuring with reasonable accuracy, the dust content of the combustion gases.

In the course of the last fifteen years as the result of innumerable experiments we feel that we have a satisfactory solution on the instrumental side. With our equipment a sample of the gases is drawn off at the same velocity as that in the flue and passed through an alundum filter. The dust is removed by being deposited on the filter walls. At the end of a suitable period of sampling the filter is removed and weighed. From this the amount of dust contained in the sampled gas is found. The total amount of gas extracted is found from the readings of an orifice plate meter which is part of the apparatus and is always in the flue gases so that condensation problems are eliminated. From these two figures the weight of dust per cubic foot of gas can be calculated and also from other measurements the total amount of dust passing through the flue can be determined.

A difficulty encountered by past workers on this problem has been the high moisture content of the combustion gases due to the water from the slurry. This amounts to about 40 per cent by volume of the gases and its condensation on contact with the atmosphere gives the familiar "plume" from cement works chimneys which is referred to by the "man in the street" as "smoke."

No mechanical process is one hundred per cent. efficient and in order to reduce any nuisance to a minimum it is necessary to discharge the combustion gases under conditions such that their presence will not be a trouble. This problem is of great complexity but it can be said in general that the greater the level at which the gases are discharged the less likelihood there will be of causing a nuisance. One is limited here by practical considerations, the configuration of the surrounding terrain and the course of the air currents. Each problem requires to be dealt with individually and it is difficult to generalize. In some cases a chimney height of 200 ft. is adequate though usually a minimum height of 250 ft. is required. In one case from observation of the air currents by means of smoke bombs suspended from a large balloon it was found that a minimum height of 400 ft. was required.

In addition to tests on the actual dust content of the combustion gases regular tests are made of dust deposition in the surrounding district by the standard methods developed by the Department of Scientific and Industrial Research. One type of equipment consists of what is in effect a large rain gauge. The dust deposited in the receiving funnel is washed into the receiving bottle by rain. The rain itself also carries some dust washed out of the atmosphere. Any deposit in the funnel itself is also added to the contents of the receiving bottle. The material caught by this gauge is analysed each month and the amount of dust deposited in tons per square mile per month of thirty days is calculated.

This test is a very laborious one and a simpler test is also used. In the simpler test six glass Petri dishes about 3½ inches in diameter are exposed at each location and the amount of dust deposited in them per month is measured. From the chemical analysis of the dust it is possible to obtain an approximate figure for the proportion which has emanated from a cement works chimney.

Some years ago the Department of Scientific and Industrial Research carried out exhaustive tests and issued the following classification of places in relation to the dust deposit in terms of tons of dust per square mile per month.

Class	*Dust deposit tons/sq. mile/month*
A Health resorts and seaside towns, e.g., Tunbridge Wells, Harrogate, Southport	Less than 13
B Small towns. ..	13 to 38
C Large towns (not highly industrialised)	38 to 64
D Industrial areas, e.g., St. Helens, Newcastle-on-Tyne, Sheffield	Greater than 64

Discussion

Dr. F. J. Eaton (Institution of Gas Engineers) said he thought all would agree that the organizers of this most successful conference were to be congratulated both on the choice of subject under discussion and on the selection of authors who had so clearly described the steps the various industries were taking to mitigate air pollution by industry.

It was a curious reflection on the human race that in the main we seldom carried out improvements from altruistic motives and were forced to take action for our own good. This was particularly well exemplified by the dust hazard and atmospheric pollution. The problem of dust could be sub-divided into two clearly defined subjects. First, there was the explosion risk of finely divided particles of combustible matter in dust laden air, for example, in the mining and flour milling industries. Explosions were obviously dangerous and immediate action was taken to prevent them. The second subject, and that which they were discussing, was the effect of dusts on the health of the community. The effect of this on the human race was less dramatic but more insidious, and for that reason progress in combating it had until recent years been very slow. Dr. Eaton suggested they had been forced to take the necessary steps because of the changing labour position. The heavy industries, in order to attract the labour they required, had got to improve working conditions. This was a growing and powerful incentive. The papers presented showed that action was being taken by many industries and they could expect a more rapid advance in the abatement of industrial dust nuisance in the future.

As a member of the Gas Industry, he had been pleased to note the cleanliness of the air at Torquay Gas Works, which was proof of the effectiveness of the steps taken by Mr. Denton to reduce dust pollution. The low pollution should be read in conjunction with the large quantities of solid fuel handled—73,000 tons of coal and 48,200 tons of coke per annum. In preventing dust pollution a first essential was to determine for each possible source the quantity and particle size of dust released to the atmosphere. This had been done for gas works and was recorded in the paper by A. J. J. Wiseman to which Mr. Denton referred. Wiseman had shown that coke handling accounted for 73 per cent. of gas works dust pollution. Considerable attention was being paid to coke screening today and a survey of some 125 plants had just been completed. Many of the existing plants were open. Experience showed that the screening plants could operate largely automatically, using supervisory labour only; they could be totally enclosed and the problem of dust control therefore became much easier.

Mr. Burke in his paper had mentioned the difficulty of high moisture content in determining the dust content of some combustion gases. This problem arose in connection with producer gas for transport during the war, and one method was described by E. A. K. Patrick, "An Electrostatic Method for Determining Dust in Wet Gases," J.S.C.I., 1947, **66**, 249. He would like to know if Mr. Burke had used this method.

Coming to a general comment, Dr. Eaton said he felt it was a pity they had not had a paper from the moulding industry which was responsible for providing the new improved appliances and in which they as a society were so much interested. He thought it should be recorded that very big advances have been made in recent years in this industry. The floor was being replaced by mechanical moulding for which it was easier to provide the necessary ventilating ducts.

P. H. Saunders (Liverpool) said that once again they had listened to the presentation of interesting practical Papers which did credit to the Society. He was pleased to learn that the thermal efficiency obtained during the Warwickshire colliery test was over 67 per cent. and that that was the standard the N.C.B. was trying to achieve, for up to a few years ago he thought the average throughout the country was little over 50 per cent. and at many individual collieries not much above 30 per cent.

It was indeed regrettable, as Mr. Higginson had remarked, that certain local authorities should press their complaints more energetically after the collieries were nationalized. Nevertheless, Mr. Saunders said he had found excellent co-operation so far as nationalized industries were concerned, particularly the Railway Executive.

He thought that Mr. Higginson's listing of problems at collieries and indication of their determination to overcome them omitted one of the most important factors in the attempt—a factor so ably stressed

by Mr. Duguid the previous day—that was the training of firemen. Not only, he said, was training necessary for operators of mechanized stoking units, but efficiently trained firemen would assist greatly in overcoming problems in the period before mechanization was carried out. He thought the N.C.B. had all the facilities for carrying out such training. Another factor which was so well covered during the previous session did not seem to be mentioned. It was instrumentation, and Mr. Saunders said it would be interesting to learn to what extent the installation of measuring instruments was included in the proposals. He asked Mr. Higginson what form of stoker control was in operation during the test described in the Paper, as the load was, no doubt, the usual widely varying load, and the fact of a clear chimney all the time indicated prompt anticipation of load changes.

Mr. Saunders thought that Mr. Denton's description of gas production at Torquay was excellent and that Torquay was very fortunate—far different from some localities where residents were living in sulphurous and smoky atmospheres adjacent to gas works. He knew from his own experience that considerable reconstruction was going on, but it would be many years before the old type of horizontal retort was completely replaced, and that was the type which caused the most objectionable nuisance. He felt that some short term measures should be adopted in those cases to collect the smoke by extractor fan and either burn it in a waste heat furnace or at least pass it out through a very high chimney.

On the question of electricity, Mr. Saunders offered no criticism, but asked Dr. Crossley to explain the chemical composition of the white plumes which issue from certain high power station chimneys. His view had been that generally speaking it was not smoke, but moisture and water vapour similar to vapour trails from high flying aircraft, but he would like Dr. Crossley's comments on the matter, also to ask him if he had any information on the use of supersonic waves for arresting not only grit and ash but smoke as well.

Mr. Saunders then asked Mr. Turner for a brief description of the operation of the smoke consuming device for shunting locomotives shown in his Paper. The design seemed to indicate the use of both live and exhaust steam.

He went on to ask Mr. Burke, with reference to the balloon smoke tests which showed the required height of chimneys in one instance to be 400 feet, what the maximum height of adjoining buildings was, as the recognized relative height of a chimney to pass smoke into a clear stream of air unaffected by down currents was $2\frac{1}{2}$ times the height of adjoining structures.

Finally, Mr. Saunders said this session would have been complete if it had included a Paper on what local authorities were doing, as quite recently he had seen buildings in the streets completely obscured by smoke from a Heath Robinson device used by some local authorities for melting tarmac during road surfacing operations.

Councillor The Revd. A. Brooke Westcott (Chairman, Corby) said he had been prepared to move a resolution on the general subject of the papers, namely, Policies for the Prevention of Industrial Air Pollution, suggesting the Society itself should formulate a policy. Though he was not permitted by the Executive to move this resolution, in fairness to his Council and those members who were expecting such a resolution, he would read it and speak on the subject in a manner suitably modified.

The resolution was: "In order that the problems connected with atmospheric pollution arising from industrial processes may be vigorously tackled, the National Executive be instructed to make a thorough survey of the present position and of the difficulties involved, and to this end they consult with the industries concerned, with the National Associations of Local Government Authorities, Government Departments, and other Societies and Associations whom the Executive may consider are interested in the subject, and at the earliest possible date issue a comprehensive report of their investigations, together with long and short term policies for reducing and ultimately eliminating such pollution."

This resolution, he said, was framed to embrace the advice offered by local authority members, who had shown remarkably strong support for Corby Urban District Council's campaign for the prevention of industrial air pollution, and he tendered his Council's thanks for this.

[The Chairman here requested the speaker to confine his remarks to the papers under discussion. The resolution that had been read had been carefully considered by the Executive Council, which had ruled that it should not be moved during a session of the present conference, but should be

examined by the Conference Committee with a view to being dealt with in a more suitable manner. Mr. Westcott therefore concluded his remarks.]

Alderman L. Munro Cobb (Margate) said that under the heading "Smokeless Fuel," an unlimited amount of power was wasted round our coasts and in our rivers by the twice daily rise and fall of the tide, and appealed to scientists and engineers to discover a means of utilizing it. The power was there and it surely could not be beyond the brains of man to make a use of it, and millions spent on the scheme would, unlike groundnuts, give a sure return.

James Law (Sheffield) said that when he was a small boy he used to read Hans Christian Andersen's stories and other fairy stories with such enjoyment, and the reading of the five Papers, dealing with the key industries of Britain, gave him the impression that he was again reading fairy stories.

He was not conversant with what was happening in Warwickshire, Torquay or even Tomtopia, but he did know what was taking place in Yorkshire and Derbyshire, and without labouring the point with too much detail, would give some salient features with regard to each of the industries concerned as it affected them.

1. *Collieries*, of which there are 14 in the area, had been given instructions to burn slurry under the boilers. Mechanical stoking is being replaced with forced draught hand-fired furnaces for this purpose, and the smoke emission and grit deposit were on the increase in consequence. From 32 observations taken recently the average black smoke emission was 15 minutes per half-hour, and that area was considered to be better than other collieries in the vicinity. There was an alleged shortage of manpower in the mines, but at one colliery working 12 boilers there were 12 firemen on each shift, and another with 13 boilers had 13 firemen per shift. The "long term" policy was electrification from the grid, but the "short term" policy, which was apparently left to the Area Board to decide, was one of retrogression and hoping for the best. If black smoke showed loss of efficiency and wasted fuel, colliery chimneys were bad. No definite date could be fixed for improvement.

2. *Gasworks*, of which there were two, with obsolete horizontal retorts, in a very congested housing area, were so bad that part of the roof had been removed to enable the fumes to escape, as the men were refusing to work under the bad conditions. Some alleviation of the situation was promised for 1953, when new vertical retorts would be put into operation, providing the demand for gas did not increase too much by that date, but he reminded the conference that they were about to commence a large rearmament programme.

3. *Electricity*. There were four large power stations in the Don Valley burning almost a million and a half tons of fuel per annum. At two of these power stations the cooling towers were about 60 feet higher than the boiler chimneys. The condensing vapour forced the sulphur-laden fumes to ground level, and the whole neighbourhood for a distance of about half a mile in the wind direction was continually covered with a blue haze. The smoke from any individual chimney was seldom excessive, but the aggregate due to the condensing vapour was appalling.

4. *Iron and Steel Manufacture*. During the past two years the use of oxygen as an accelerator for melting had been introduced. This had speeded up purification, time of melting and increase of temperature to a considerable extent, but from a public health point of view had created a serious nuisance. The application of oxygen caused a rapid boiling of the material and a dense brown smoke, which was in reality iron oxide in finely divided particles. Research had shown that the major proportion of this dust could be collected either dry or set, but so far no attempt had been made to implement these findings, on the grounds of expenditure.

5. *Cement Manufacture*. In spite of strong protests from the Council for the Preservation of Rural England, a large chimney 400 feet high had been recently erected almost in the centre of the Peak National Park at Hope in Derbyshire, in order to extend the manufacture of cement. The existing chimney, which was not so high, carried a continuous plume from its top over the valley, and this plume just dissipated slowly in the atmosphere, but in its path, particularly in agricultural land, a grey sheen could be readily noted. Mr. Burke assured them that such dust would be dissipated at that height and would not be deposited on the surrounding inhabitants—they would wait and see, because what went up must come down somewhere.

Recently, these industries had been

invited to join the National Smoke Abatement Society in order to help with the work of reducing atmospheric pollution, and they welcomed the gesture of their entrance.

It was of little use, however, putting up papers of the kind that had been submitted, when most of the delegates, from the North at any rate, were well aware that such policies were not being wholeheartedly pursued.

If they had any doubts with regard to industrial conditions, the Atmospheric Pollution Records, which were published each month, showed the steady rise of solid matter deposited in almost every manufacturing town and particularly in London and the north-east.

Mr. Law said he would feel happier if these people came forward honestly and said that they were doing what was practicable, but could not hope to cure the nuisances, rather than have to listen to and read pretty fairy stories from remote parts of England with the object of lulling them to sleep.

G. H. Wilkinson (Chief Sanitary Inspector, Corby U.D.C.) stated that after carefully studying Mr. Turner's paper, he was still searching for the steel industry's policy, and also evidence of the "strong campaign to eliminate this evil."

Whatever the outcome of the research into blast furnace conditions, the bleeder would be a permanent fixture. He was surprised at the continued use of a Heath Robinson arrangement for closing the bleeders. Surely it was not beyond the technical brains in the industry to devise an automatic self-closing valve. In regard to the research into the causes of slips, he quoted an American technologist—"No one is absolutely certain what occurs, since no one has ever been inside a blast furnace when one occurred."

Mr. Wilkinson was glad of the confirmation of his own opinion, often challenged, that coke ovens were an integral part of the iron and steel process. But why worry over the minor and local pollution from the pushing of coke, when the serious sustained pollution from the coal charging operation was apparent to anyone who lived or worked close to a battery? In this respect, Mr. Turner had mentioned momentary suction inside the oven as reducing the nuisance. In view of the fact that the process of charging took anything from three to five minutes, of what use was one moment of suction? It was necessary to come down to basic facts and realize that to eliminate or appreciably reduce the nuisance, radical alterations in structure and methods were necessary.

In regard to pollution from open hearth furnaces, the stack gases were heavily charged with dust during the first 60-90 minutes of each "heat." The industry apparently relied on lengthy flues to remove residual dust. This would perhaps be successful if the flues were several miles in length! Apparently the B.I.S.F. had no knowledge of the developments in America, where they were using venturi scrubbers, sonic and electrostatic precipitators, with efficiencies of 96 to 99 per cent.

On the matter of traffic, there was clear evidence of the industry's attitude to atmospheric pollution. Apart from exceptional operations, diesels were the answer; the industry was aware of the fact, but were afraid of the cost. In this regard, the industry could, if it were sincere, prove its interest in the aims of the Society.

Mr. Wilkinson then pointed out that there was no reference to bessemer converters, nor apart from two photographs, to sintering. Was the industry so indifferent to pollution that they did not realize the nuisance created by bessemers? Was Mr. Turner aware of the recent sudden interest of B.I.S.R.A. in the material blown out of the converter? Mr. Wilkinson referred to the inevitable greater use of bessemer converters in the future, and the increasing use of oxygen enrichment, which would increase the rate of pollution. He begged the industry to carry out research into methods of arresting converter dust. He drew their attention to developments at a Leamington Spa plant which had been completely ignored by the industry, probably because it merely reduced the pollution and was not of economic benefit to the industry.

During the past five years considerable research had been carried out on the sintering process. A report was expected soon. He awaited its publication with considerable interest and hoped the B.I.S.F. would supply him with a copy.

In conclusion, Mr. Wilkinson stated that at a meeting of the Society's Technical Committee earlier that year, a representative of the B.I.S.F. who was present stated frankly that he had learnt much from the discussion. Probably the delegates from Corby could console themselves with the thought that the industry had now learnt a little more. But, he asked, how much longer was this education going to take before it bore some fruit?

John H. Wright (Chief Sanitary Inspector, Smethwick) congratulated the Conference on having heard such an inspiring symposium. He said that he was among those who had been engaged in clean air propaganda for nearly forty years, and that during most of those years the processes represented by the gentlemen on the platform were regarded as Public Enemies Nos. 1, 2, 3, 4 and 5. Since there was said to be more joy in heaven over one sinner that repenteth than over ninety and nine which need no repentance, how much joy must there be today in the hearts of veteran members of this Society who had been vouchsafed the spectacle of no less than five penitent sinners " selling " clean air to them ? He was glad that he had lived long enough to witness it.

Councillor Mrs. E. Landen (Dartford) said that she lived in the Swanscombe area of North Kent, where for many years they had experienced dust nuisance from cement works. Although they were still troubled with the dust and would welcome further improvements, she would like to say that there had been considerable improvements during the last few years.

Authors' Replies

N. Higginson said he agreed with Mr. Saunders that many colliery boiler plants worked at very low thermal efficiency and that the average throughout the country a few years ago was only 50 per cent., with individual plants attaining only 30 per cent. No definite standard of thermal efficiency was laid down by the National Coal Board but it could be generally stated that the aim was to effect a consistent reasonable efficiency over the working week and not attempt to get very high efficiencies on spot tests during the full load shift by installing plant only to this end.

With reference to the tendency for some local authorities to press complaints more energetically after nationalization, it should be made clear that this was not to be regretted but must be borne in mind when installing new plant. It is realized that more responsibility must now be borne by the industry as a whole with its new nation-wide control.

On the problem list given in the paper the training of firemen was not included since it did not form a problem at the colliery in question. It would be seen however, that under items 1, 2 and 3 of the list appreciation of the failings of the firemen was made and in this case the substitution of mechanical stokers was the solution. The National Coal Board were now engaged upon a training scheme for all boiler firemen. A mobile field unit had been set up and was being used at collieries. This unit was in the charge of a qualified and experienced combustion engineer. Training of boiler chargemen had been undertaken at many of the collieries by taking advantage of the schemes run by the Ministry of Fuel and Power. It was not an easy matter to train colliery boiler firemen since they had largely been bred in a " firehole " tradition as was pointed out in the paper.

Regarding instrumentation, the policy of the Board were to fully instrument plant comprising mechanical stokers and partly instrument other hand-fired shell boiler plant according to circumstances. In the case quoted in the paper the plant was fully instrumented comprising visual gauges for side flue suction and forced draught together with carbon dioxide and flue gas temperature indicators to each boiler.

The form of stoker control at the colliery given is manual and the good results throughout were gained by the employment of an intelligent operator—such employment being possible where conditions were good. The load was certainly widely fluctuating but no difficulty was ever experienced in meeting the variations and a clear chimney top was always found.

Mr. Law had likened his paper to a fairy story by Hans Anderson. He would point out that Mr. Law, in his opinion, was like the proverbial ostrich and was burying his head in the sand by assuming that there were no other problems which must be solved before atmospheric pollution was eliminated and that these problems must be weighed in the balance to determine action. His paper was presented to show that smoke abatement in the case quoted was effected by installation of plant designed to overcome, in addition, other pressing problems. There were other cases in which action might appear to militate against smoke abatement. Such action, which Mr. Law pointed out, took place in the National Coal Board Area with which he was familiar and, no doubt, was dictated by other motives. It was easy to see that the example of substitution of hand-fired furnaces for mechanical stokers which he quoted, was a measure to effect the consumption of an unsaleable fuel thus liberating better fuels for industry and the home. Mr. Law might be

interested to know, that as yet, no reliable method of burning slurry by mechanical means had been evolved but investigations were being actively pursued. In the Warwickshire Area one experimental installation was being erected.

The manpower which Mr. Law gave of twelve men for twelve boilers at one colliery, and thirteen men for thirteen boilers at another he could not dispute, since he did not know the colliery ; but here again, no doubt, these collieries were burning slurry which demanded very heavy work and these men were making coal available to the market just as much as though they were actually producing it. One man per boiler was expensive and he would like further details of this case so that the matter might be investigated. The costs of producing power must also be borne in mind and urgent economies in this direction must be made at some collieries where the figure was exorbitant due to the use of high price fuel and little or no margin of profit was available.

New plant of a capital nature was probably planned and ordered for such collieries, and where not, the life of the colliery might not warrant it ; but for such restricted life it must carry on producing coal at low cost until its output was achieved elsewhere. The problem of air pollution in such cases must be tackled by better firing techniques, etc. One way of helping slurry burning furnaces to reduce smoke emission was to fit secondary air arches as pointed out in the paper and also to prevent simultaneous charging of fuel by systematic firing on the battery of boilers.

The policy of the Area Boards, he would inform Mr. Law was not one of retrogression as he stated but one of resuscitation with an eye on each colliery to provide the maximum coal output for minimum cost. Many of the collieries in the Area in which Mr. Law operated were left with the slurry problem at the Vesting Date and he did not consider that Mr. Law was giving facts when he stated the fourteen collieries constituting the Area were *ordered* to burn slurry—not all collieries even in Yorkshire have washery plants.

The National Coal Board had a power production policy, and it was being pursued, but it was also taxed with supplying the life blood of the nation and there was a shortage of supplies. Each colliery had its own specific problems as pointed out in the introduction to the paper. Electrification was being pursued actively and it was well to point out that three to four years, from date of plant orders, are required to effect some of these electrification schemes.

In his opening remarks Mr. Law stated he was not conversant with what was happening in Warwickshire, Torquay or Tom-topia. Might he respectively refer him to his paper and that of his fellow authors ; they would give him a lead. In this respect he has displayed a most parochial outlook since to give policy for such bodies as Gas, Electricity and Coal an overall picture was necessary. The reference in his closing remarks to "fairy stories from *remote* parts of England" further demonstrated a parochial outlook ; indeed, he suggested that Warwickshire was of some importance industrially as a glance at any atlas would show. It should be specially well known in Yorkshire as any of their county cricket players would testify without reference to Hans Andersen.

It was gratifying to hear Mr. Wright speak of penitent sinners "selling them" clean air. The National Coal Board realized they rank with M.P's and mothers-in-law as targets for criticism and he would assure him that notwithstanding their policy was towards less smoke pollution and he might yet be further gratified by next year's representative giving details of more progress.

J. W. Denton said that Dr. F. J. Eaton had stressed the importance of reduction of fine grits arising from the handling of coke and the gas industry had appreciated the importance of arresting this dust at source.

Technical investigation was necessary to determine the quantities and the micron sizes related to this nuisance, and from this determination suitable collecting plants provided in the installations. At Torquay the coke handling plant was totally enclosed and the dust collected here, along with incidental dust collected in the other vacuum plants on the works, was briquetted with an admixture of pitch to make a fuel for use on boilers. It was necessary to appreciate that dust, when collected, must either be utilized or disposed in such a way as to create no further nuisance. Great emphasis should be made on the elimination of dust at source. The emission of dust or grit through high chimneys, whilst providing a means of dissipating the nuisance over a large area, was not a solution to the general problem.

Mr. P. H. Saunders and Mr. James Law both referred to nuisances arising from the operation of horizontal retort houses.

In speaking of the many small works which certainly, in their opinion, did not reach the standard of their station at Torquay, they pointed out the smoke and dust nuisances from horizontal retort houses. The gas industry was now able to arrange centralization of production and elimination of the small works was thus being carried out by affording bulk supplies from large stations. He would urge the Society to support the gas industry on those occasions when it contemplated the erection of large modern stations which, when in operation, should be a contributing factor to smoke abatement.

Dr. H. E. Crossley said that Mr. Saunders had asked for an explanation of the chemical composition of the white plumes which could, at times, be seen emerging from high power station chimneys. On some occasions, when there were dark skies, ordinary chimney emission would appear whitish entirely due to an optical effect. With high chimneys, however, there might be a certain amount of white steam plume produced as a result of the chilling of the gases. This emission was not likely to have any significance with regard to atmospheric pollution.

Mr. Saunders also asked about the use of supersonic waves for arresting grit, ash, and smoke. He was not familiar with any application of supersonic waves for arresting smoke, but it had been suggested that they could be used in combustion chambers to cause rapid vibration of the fly-ash carried by the gases. It was said that this rapid vibration caused the particles to agglomerate into big aggregates which then fall back. Unfortunately, this application was only suitable for extremely hot furnaces of the slag tap type, and as yet there was only one furnace of this type in British power stations.

Mr. Law had expressed considerable doubt about the sincerity of all the papers given in the session. Naturally he could speak only for the British Electricity Authority, and on their behalf he assured the conference, and Mr. Law in particular, that his paper was prepared with complete sincerity.

Mr. Law also claimed that particularly bad conditions resulted from the power station emission in the Don Valley. It must be remembered that the British Electricity Authority had to consider the conditions surrounding more than 200 power stations, and in these days of shortage of labour and limited supplies of building materials, it was not possible to make changes in all these cases simultaneously. Many cases were being investigated and improvements were being effected wherever practicable. These improvements were subject only to the limitations of supplies and the outstanding life of the station, as mentioned in his paper. He could not promise Mr. Law that as a result of his remarks the Don Valley power stations would receive priority attention, but he could promise him that they would receive proper attention according to the relative merit of these cases.

Neil H. Turner said, in answer to Mr. P. H. Saunders, that the smoke consuming device was basically the original Marcotty, modified to suit shunting locomotive conditions of operation, *i.e.*, prevented from coming into operation unnecessarily every time the locomotive stopped.

The device now started to operate when the fire-door was opened and remained active for a length of time fixed with due regard to the type of coal used and the general operating conditions.

It was hoped that a general description of the device would appear in the technical press.

In answer to Alderman L. Munro-Cobb, Mr. Turner said that the use of oxygen in melting furnaces was relatively new, and there was no doubt, should that process be retained, that equipment would be added to recover what was also quite an appreciable loss to steel making. However, solutions which might appear simple to the uninitiated might necessitate a fair amount of investigation before they could be applied with full security of operation of the plant.

Mr. Wilkinson pressed his criticisms to such an extent that he tended to over-do them and one felt tempted to ignore them. However, in respect of self-closing bleeders, Mr. Wilkinson was under a misapprehension. The self-closing of the bleeder had been in existence in this country since blast furnace gas had become a useful fuel, thus for quite a long time.

Interference with self-closing for specific and according to Mr. Wilkinson, unreasonable purposes, would not necessarily be condoned every time, even by blast furnace operators, especially when the blast furnaces concerned were relatively modern, i.e., were designed to stand a fair pressure at the top.

In his references to coke ovens, why should Mr. Wilkinson choose to play with the word "momentary?" What

were the five minutes of charging time in relation to the 19 to 20 hours of carbonization if not a moment? Provided the suction was maintained evenly right across the ovens the method mentioned for dealing with the dust arising when charging the ovens would hardly be improved.

Mr. Wilkinson made a very drastic statement on open hearth furnaces. Dust emission varied from plant to plant both with regard to rate and duration. It had been admitted that the use of pitch-creosote and oxygen had tended to increase the amount of dust emitted from the chimney.

The statement that the industry was satisfied to rely on lengthy flues to remove all the entrained solids was a distortion of the facts. The developments attributed to America are well known to the industry and would be given full consideration if they proved in this particular instance to be as satisfactory as Mr. Wilkinson claimed them to be.

Works Locomotives.—Mr. Wilkinson was not fully consistent. On the one hand he condemned a straight attempt at trying to prevent smoke reaching the atmosphere and on the other he blamed the steel industry for not doing so elsewhere.

The use of indifferently maintained Diesel locomotives would be conducive to an appreciable amount of smoke being liberated. This point was emphasized by Sir Ernest Smith in his introductory remarks. Therefore, before scrapping all steam locomotives and replacing them by Diesel locomotives, it was necessary at least to ensure that maintenance of a suitable grade was available.

Bessemers.—Mr. Turner said he had already given verbally the reason for not dealing with this particular subject.

Mr. Wilkinson complained of no reference to sintering barring the photographs. It could have been thought that the pictures in this case were more enlightening than words. They showed at least that dust eliminating equipment went in as a matter of course and not as an afterthought.

The iron and steel industry were fully aware of its share of what had to be done to prevent atmospheric pollution but the solution of some of the problems was not just as simple as Mr. Wilkinson would lead them to believe.

E. Burke said that Dr. Eaton had referred to an electrostatic apparatus for determining dust in gases with high moisture content. This method had not been used in the cement industry. A somewhat different one had been developed which was found simple and the apparatus reasonably portable. A sample was extracted from the flue at the same average velocity as the gases and passed through an alundum filter to extract the dust. The gases then passed through an orifice meter for measuring the flow. Both filter and meter were immersed in the gas and thus condensation difficulties were removed.

Mr. Saunders wished to know the reason for the 400 ft. chimney at the cement works in the Hope Valley. The height of this chimney was not governed by that of the maximum height of the adjacent buildings which was approximately 80 ft. above the base of the chimney. There was a hill at the back of the chimney and the height was chosen to avoid the effects of down-draught from this hill.

Mr. Law's reference to the hieght of the chimney erected at the cement works in the Hope Valley gave the impression that in some way this height was essential to the increased production at the works. Mr. Burke wished to say quite categorically that the provision of high chimneys (and also electrical precipitators) at cement works had only one object—the preservation of amenities. Policies for the preservation of amenities were being pursued as far as was practicable by most of the cement industry, as had been clearly demonstrated many times, by the provision of high chimneys and electrical precipitators on new works and extensions. The policies followed in that respect offered no financial return to the industry: on the contrary they were a heavy expense.

Mrs. Landen's remarks were the kind that cement manufacturers were delighted to hear. It made them feel that at least some prominent local people realized that efforts were being made to give our industrial districts cleaner atmospheres. She had said that although much had been done in the Swanscombe area much remained to be done. He assured her that this matter had their close attention and they were progressing. The problems at issue took time to solve and the mounting cement production of the country did not make them easier.

Mr. Burke concluded with one remark on the nature of the dust that issued from a cement works chimney since there had

been much confusion on that point. The raw materials used for cement manufacture were either chalk and clay or limestone and shale. The dust consisted substantially of a mixture of the two innocuous substances mixed with a little coal ash. The materials became *cement* in a separate process which was carried out after the material issued from the rotary kiln.

SMOKE PREVENTION IN THE HOME—THE WOMAN'S VIEWPOINT

(I) SOLID FUEL

by

Elspet Fraser-Stephen, M.A.

Associate of the Institute of Fuel; General Secretary, The Women's Advisory Council on Solid Fuel.

There is no need for me to repeat the advantages of smoke prevention from the woman's point of view to this audience. For more than twenty years the National Smoke Abatement Society has been preaching this gospel, and pointing out the damage done by smoke within the home itself, quite apart from the harm done to buildings in our cities, and the effect of smoke on our health. These facts are well known, and are not disputed by anyone. What can still be a matter for discussion is the best method by which smoke could be reduced or prevented, and as this takes in a number of important and rather controversial factors, the argument is by no means over. If it were, the National Smoke Abatement Society could fold its hands, its work completed. We are, I am afraid, a very long way from this conclusion.

How far does a specifically woman's point of view come into this discussion? Fifty or more years ago, one could say that the woman's job was to consider how best to accomplish any particular purpose within the limits of her own home and family. Now I think it is true to say that women are fully aware that many decisions they may take within the home are finally determined by outside factors over which they have no immediate control—this applies of course to practical matters, and not to things of the spirit, which are still free.

Thus a housewife who agrees with the principle that smoke is something which ought to be abolished must ask herself three questions—first, what can I do, here and now, in this autumn of 1951 to further smoke prevention, and secondly, how far is such a thing possible for the country as a whole, now and in the future? and, finally, are there any steps which I may take as a citizen, to bring about this desirable end?

To begin with the immediate steps, the position is far better than it was some years ago, when those who wished to use smokeless fuels for space heating were obliged to burn them in not very efficient open fires or efficient but very unattractive-looking closed stoves. As a result of deliberate national policy, to which scientists, fuel technologists, Ministries, coal merchants, manufacturers, and many others have contributed, a very large number of appliances have been designed and produced, most of which are capable of burning smokeless solid fuels, as well as bituminous coal, with very greatly increased efficiency and with less smoke emission. These appliances have many other advantages, which I need not develop here, but will simply mention—their attractive appearance, ease in operation, and relatively low cost for continuous space and water heating.

The first task, therefore, which I would recommend to our housewife is to go into her living room and look at the fireplace with a critical eye. If it contains an old-fashioned basket or stool grate, of which far too many are still made and sold, she should do away with it forthwith, and put in either an improved type of fire, or a modern openable stove. What about the landlord—for three-quarters of our people live in rented dwellings? Free standing stoves are clearly tenant's fixtures, and also I believe the simpler type of modern fireplace without a back-

boiler. It is, of course, advisable to consult the landlord and come to an agreement. Incidentally, this point is allowed for in the Manchester Corporation Act of 1946, and I see no reason why these provisions—i.e., agreement between landlord and tenant to install a modern appliance, and thereafter vary the terms of tenancy, and if no agreement can be reached, reference to the County Court—should not be extended to the whole country. What about cost? This is moderate as things go nowadays, and there is a very good case for allowing them to be sold on a deferred system, and thus spread the cost over a few months. What about installation and management? She can set her mind at rest if she arranges the former through an accredited distributor, whose firm is a member of the Coal Utilization Joint Council's Panel. Help in proper management can also be obtained from an up-to-date coal merchant or from the regional staff of my own organization, the Women's Advisory Council on Solid Fuel.

Having got her new fire or stove installed, our housewife can feel that she personally has not only taken an active and useful step towards lightening her own labour, reducing her fuel costs, and increasing the comfort of her home, but has also helped to make her own city or town cleaner, to the benefit of herself and her neighbours.

However, if she is quite objective, she will be candid enough to recognize that the new fireplace or stove may not be *completely* smokeless. The solid smokeless fuels, coke, anthracite, and various processed fuels, mostly produce a certain amount of smoke when the fire is first lit, or refuelled, and in any case some chemical fumes are emitted which may not be visible, but which will certainly contribute towards the corrosion of stone-work. She can do something by careful operation towards reducing this intermittent smoke. Gas ignition heats up the fuel quickly, and is in any case desirable if smokeless fuel is used. If a large bright fire is built up, and then carefully fuelled with small quantities, there will be less smoke. An openable stove can be operated in much the same way. In general, however, smokeless fuels will cause very much less atmospheric pollution than if the appliances are fuelled with bituminous coal.

It is probably when the housewife fails completely to get any coke or other smokeless fuel, that she begins to realize that smoke abatement is a national as well as a personal problem. The stark truth is that there is nothing like enough smokeless fuel in the country to supply our 16 million or more domestic fires. The quantity of coke for the domestic user is at present strictly limited by various factors—availability of gas coals, capacity of gas—cooking plant, export demands. The Simon Report estimated that within 20 years—now 15—the whole domestic consumption of solid fuel, which the Report considered should bear the main winter space and water-heating load, would be smokeless and not bituminous. Many people now believe that this prospect is completely utopian.

To take each smokeless fuel in turn, one may start with the natural coals such as anthracite and Welsh dry steam coal, of which the present domestic consumption is about 2.3 million tons a year. There is very little hope of increased domestic supplies for at least the next five years. For various reasons, anthracite is expensive and difficult to mine, and there is a strong demand abroad for every ton that is mined. Under present conditions, burning anthracite in our own homes—and in many ways it is a superlative fuel—is quite simply a luxury which we cannot afford.

Present consumption of other smokeless fuels is about 3.5 million tons, making a total for all smokeless fuels of about 6 million tons a year. The future supply of gas coke, and the processed fuels such as low temperature coke or Phurnacite, depends first on the provision of suitable coals by the National Coal Board, and these are limited not only by the general shortage of all coal but by natural scarcity. By far the greatest proportion of coal reserves in the country, and practically all the 30 million tons at present used for domestic purposes, is quite unsuitable for making into coke. The extension of coking and processing plant will certainly be slowed down by the need to reduce capital expenditure of all kinds, except where directly related to our rearmament programme, which, we may remember, is to cost about £4,700,000,000 during the next three years. Any great expansion of coking plant, unless to provide coke for industry, is again a luxury we cannot afford at present.

Can one look further into the future? I suggest that our housewife by this time will at least be ready to admit that unless the 30.2 million tons of bituminous coal used in our homes is turned into smokeless fuel by the wave of a magic wand, it is

very unlikely indeed to happen in any other way by 1965, when the Simon Report dream is due to come true.

Can bituminous coal be burnt smokelessly ? Here one can find definite progress. I can only refer briefly to this, as it consists to some extent of scientific research which I am not qualified to expound. However, it is cheering to know that the problem of smoke is being actively studied at Leeds, at the Fuel Research Station, and at the British Coal Utilization Research Association. New open fires, using the down-draught principle, are already on the market, and there is a system of whole-house heating being developed, in which one small furnace warms the house and heats the water using ordinary coal and producing relatively little smoke. There are certain inherent difficulties in burning bituminous coal smokelessly in an open fire. It is very much easier in a closed firebox, but research is proceeding in both directions, and the future of these is full of hope, incidentally, the proportion of large house coal in the total output of the mines is tending to decrease, mainly owing to mechanisation. This circumstance is yet another reason for turning away from the old-fashioned open fire, and developing appliances which can burn smaller coal or smokeless fuels efficiently.

To return to our housewife, who is after all the person who will ultimately gain or suffer by whatever national policy is pursued. If she installs a modern open fire or openable stove now, she can use in it almost any type of solid fuel she can get, and she should in this immediate situation try to use everything, including even the smoky coal dust on her cellar floor, in order to provide more fuel for industry and diminish the strain on gas and electricity supplies. When there is an acute shortage of coke, it would be fairer to everyone if what coke there is should be used on, for example, independent boilers, which are unsuitable for coal, than in modern open fires which will burn coal, almost as efficiently as coke. Then there is the urgent question of those six million dwellings in the country without piped hot water. In my personal opinion the task of providing these homes with solid fuel space and water heating appliances has a higher priority than anything else—yet supposing it were done overnight this might mean an increased demand for coke or coal of at least 3 million tons, which is simply not available at present. Pressure in one area for more coke will, under present conditions, simply mean less for someone else, and will not affect the total amount of smoke emitted. One might perhaps argue that the amount of smoke is also not equally shared. Manchester could do with less of it, and possibly—let us say—Bournemouth might put up with a bit more. This is an argument which one could hardly develop in the presence of local authority delegates, but is the reverse side of the smokeless zone, under present conditions.

We may regret the spacious days of a wood-burning England, before we used up our forests and had to turn to coal. We may wonder if the industrial revolution made us happier as well as richer. But taking a very long view indeed, we are in fact gradually moving out of the smoke of Victorian cities towards the cleaner air we should all like. If we use our only natural resource, our coal, wisely and intelligently during the next few years, we shall in time be able to leave fogs and smoke clouds behind, whether they occur in the skies above us, or in the dangerous international chaos through which we are fighting our way, and will be able to develop, in peace, completely new sources of power as yet hardly dreamt of.

(2) GAS

by

Marjorie A. Lovell Burgess, M.R.I.P.H. & H.

Lectures Officer, The Gas Council

The housewife of today has to meet the challenge of problems which are the result of a changing world. She may be called upon to create a home within the framework of very limited accommodation, and without any domestic help. Rising prices mean continued emphasis upon economy. By providing two smokeless fuels, gas and coke, the Gas Industry offers the means by which the housewife

may readily secure, for the small and servantless home, and within the limits of a planned budget, high comfort standards.

No one can deny that the Gas Industry, with its provision of the gas cooker in place of the coal range, was the pioneer of the clean, labour-saving kitchen. And although Britain cannot, as yet, share with America the title of " the land of the great white kitchen," the Gas Industry, with its emphasis on kitchen units, standard heights for working surfaces, and all-white cookers, refrigerators and water heaters, is in the forefront of kitchen planning.

The Gas Industry has, however, further claims to be considered by the housewife as an ally where smoke prevention is concerned.

As an industry we yearly carbonize nearly 26 million tons of coal ; that is to say, we break coal down, by means of various processes, into gas, coke and by-products. The by-products are those chemical ingredients that disappear up our chimneys in the form of tarry vapours, coal particles and sulphur compounds when we have coal fires.

It is not within the scope of the paper to give statistics relating to the tons of smoke which are poured each year into the atmosphere from factory and domestic chimneys in the form of unburned coal particles, or of the damage done thereby to health and property. And perhaps it is just as well that the town housewife does not realize that she is going about with blackened lungs while her country sister's lungs are a nice, healthy pink. But the housewife ought to know that in obtaining gas and coke from coal the Gas Industry also releases, for their proper uses, those chemical ingredients which would otherwise pollute the air in the form of smoke ; chemical ingredients which form the basis of familiar articles, used by thousands of housewives every day, such as saccharine, aspirin, food flavourings, dyes, perfumes, drugs, ointments, disinfectants, plastics and nylon. At the Gas Works the thick brown smoke, given off by the coal that is being baked in the retorts, instead of being allowed to escape into the open air, is led along overhead mains until, by condensation, distillation and purification, there is made available gas, ammonia, tar, benzole and sulphur. And tar alone is the parent of over 2,000 chemicals. Even the carbon which forms on the sides of the retorts is removed by machinery to become an ingredient in making oil paint, lead for pencils, and carbon brushes.

The point is that coal is a complex chemical substance as well as a fuel, and nowhere is that fact more fully realized than in the Gas Industry—the one industry whose engineers deliberately set out to make smoke, from good quality coal, for the sheer value of what that smoke contains.

New Heating Standards

The coal fire is dear to the heart of many people but they do not realize *how* dear it is in terms of ill health, lowered vitality, loss of sunshine, corroded buildings, drab streets and dingy homes.

We in this country still think there is something psychologically sound about an open fire. In a climate where there are so many dull and wet days we seem to need the stimulus of a colourful, cheery blaze. Fortunately a coke fire, while doing away with smoke, will give us an even greater heat, and a brighter glow.

It is interesting to note how modern methods of heating, aiming at a wider distribution of heat in the home from one central source, are beginning to influence architectural design in this country.

America, with so much central heating, has given us the open type of house where there are no inner, or partition, walls on the ground floor, apart from those of the kitchen, and the warm air is thus enabled to circulate more freely. Examples of this type of house are to be seen in this country.

Before the last war most families were housed on the general principle of one house to one family. Space heating and water heating arrangements were made on the assumption that there would be a kitchen with a boiler, and a separate living room with an open fire.

Owing mainly to contemporary housing conditions our ideas on housing have ceased to be so traditional. The conversion of old houses ; two and three-purpose rooms ; combined sitting rooms and kitchens ; the need for fuel economy ; and the almost complete absence of domestic help, necessitating the easy provision of meals, have made many housewives want to have one fire, and one fire only, that will act the part of a boiler by providing hot water, and at the same time provide a social centre—which a boiler cannot do—for the family. This one fire may be in the kitchen, with a heating appliance in the occasionally used sitting room or, more often, an open fire with the back boiler in the sitting room, and the supplementary appliance in a tiny " workshop " kitchen.

A smokeless home, and one fire providing a wider zone of heat, and also hot water, can be achieved in old houses, as well as in new ones, by installing an open, slow combustion coke grate, with gas ignition, which supplies not only a focal point for the family but hot water from a back boiler for domestic use, and also for one or two radiators, or a bathroom towel rail. Some grates have a steel plate which can be pulled up to deepen the fuel bed for overnight burning. One type of back boiler is finned, and has a gas attachment with a plug-in connection to supply hot water when the coke fire is not required. Many households, however, rely on a gas circulator, or a multipoint or sink heater, to provide hot water during the summer months, with auxiliary appliances to give independent heating as required.

In this connection perhaps I may be allowed to draw attention to the gas convector fire, which is designed not to imitate a coal fire, or a log fire, but is based on the scientific fact that where there is a fire, with a flue, there must be a circular movement of air in the room, because cold air falls, and warm air rises. (This fact alone is, by the way, sufficient argument for the provision of chimneys for all houses and blocks of flats). Slots are provided at top and bottom of the radiant panel so that the cold air, drawn in at floor level, can rise behind the panel, and emerge, as warm air, through the upper slots, thus providing for a circulation of warm air.

Choice of Fuels

At this point it is perhaps useful to consider, where the choice of fuels for domestic use is concerned, those factors which determine national policy, and those which influence the family.

From a national viewpoint we cannot be said, as yet, to have a fuel policy, but there is a growing recognition of two important facts ; (1) that the long-term use of a derived, or secondary, fuel is ultimately less costly to the nation than the burning of raw coal ; (2) that certain fuels are best fitted to do specific tasks. To take two extreme, and very obvious, examples to illustrate the second point, we cannot run our television and wireless sets on gas, and it would be both expensive and impracticable to attempt to light a coke fire, or, for that matter, a coal fire, with electricity.

The factors that influence domestic choice of fuel are, mainly : (*a*) cost ; (*b*) performance ; (*c*) appearance ; (*d*) saving of labour.

The planning by Local Authorities of heating equipment as an integral part of the design and structure of new houses and blocks of flats, and the installation of approved appliances for burning smokeless fuels—often with ducts in the walls of the living-room to convey convected hot air to the bedroom above—together with improved heat insulation and ventilation, form a welcome advance in the direction of better heating standards. In the interests of hygiene and economy, however, every family should also have, on tap, a constant and instantaneous supply of hot water for baths. It is obviously uneconomical for a housewife to be forced to light, and to maintain, a coke fire, or boiler, in summertime, or in mild spring or autumn weather, solely for the purpose of obtaining a supply of hot water for the bathroom.

For all hot water problems other than those entailed in the provision of adult baths, the instantaneous, or storage, gas sink water heater is clearly the universal panacea. Its installation means that at all times, winter or summer, day or night, irrespective of back boilers or coke boilers, the gas sink water heater can provide the housewife, at the turn of a tap, with instantaneous hot water.

One of the great benefits of auxiliary appliances, from the point of view of households with small incomes, is that they need be used only when actually required. The same argument applies with equal force where district heating and the central heating of larger blocks of Council flats are concerned. A rent sufficiently adequate to cover the cost of a maximum provision of constant hot water tends to penalise the careful user at the expense of those who make unnecessary demands on the hot water system.

As for the choice of gas for auxiliary hot water appliances, it would obviously be uneconomic, from a national viewpoint, to encourage the use of coke as a smokeless fuel, and at the same time to discourage the use of the gas which results from coal carbonization, and is also the necessary ignition for the coke. But gas and coke together—gas for speedy cooking, auxiliary heating, and the provision of instantaneous hot water, winter and summer, and coke for a more even, and cleaner, distribution of heat in the home—form a natural, economical and hygienic smokeless fuel partnership.

Our homes, and the towns in which

they are set, are inter-related. Just as gas-fired furnaces in a factory mean cleaner homes for those who live near the factory, so the use of smokeless fuels in a town home is not only rewarding to the housewife and her family in cleanliness, and the saving of unnecessary drudgery, but it is also pioneer work, bringing nearer the day of the smokeless town.

It used to be said when I was a child, before people relied on weather forecasts, that when the smoke went up straight from the chimneys it meant a fine day. When the smoke from the nation's valuable coal resources is led along the horizontal chimneys of the Gas Works, to be processed, it will be an even finer day for us all.

(3) ELECTRICITY

by

Dame Caroline Haslett, D.B.E., J.P.

Vice-President of the British Electrical Development Association and Director of the Electrical Association for Women.

(Presented by Miss Vera Norvick)

Every woman wants a home which is easy to keep clean, and she is particularly resentful of dirt and dust which she can see coming into her home. Equally harmful, however, is the dust and grime which settles from a polluted atmosphere and which although it may not be so obvious has the same result. Not only does it create unnecessary work for the housewife which increases the fatigue factor, but it causes and aggravates respiratory diseases, rickets, etc.

Atmosphere pollution from smoke comes from two sources—inside the home and outside it. Of the two and half million tons of smoke emitted into the atmosphere every year, 54 per cent. is from domestic chimneys, and the remainder is due to industry and the railways. It is indeed reassuring to realize that while electricity generating stations burn over 16 per cent. of the nation's coal, they produce only 0.4 per cent. of the smoke emitted.

According to the *Statistical Digest* of the Ministry of Fuel and Power for 1948, 37,000,000 tons of coal were sold by merchants of house coal and anthracite, and emitted nearly 1,000,000 tons of smoke. If all the coal used in power stations in the same year, namely 29,000,000 tons, had instead been burned in the domestic grates or in factories without modern methods of stoking, about three-quarters of a million tons of additional smoke would have polluted the atmosphere, and would no doubt have increased the incidence of fogs.

As the burning of raw coal is the cause of smoke pollution, if we can obtain more power from a given quantity of coal consumed, we shall not only be tackling the smoke problem, but also the other basic national problem—the need to economize in the use of coal. Sir Henry Self, in his Presidential Address to the British Electrical Power Convention this year said that an increase of 0.1 per cent. in thermal efficiency at the power station means a reduction in coal consumption of roughly 140,000 tons, and an annual saving of some £350,000. The coal used in the power station is largely of a low grade not suitable for the domestic hearth, so that a great contribution towards alleviating smoke nuisance would be made if households obtained their heat light and power from the generating station for an infinitesimal output of smoke instead of being the main contributor to it by burning raw coal in the domestic grate. It is again reassuring to know that modern methods of electricity generation are helping to solve these two major national problems together of coal shortage and smoke nuisance.

Power stations are so designed that the public gets the very best results for the coal consumed there. For instance, the Egerton Report on the Heating and Ventilation of Buildings comments on the value of the high chimneys in diffusing what little smoke, ash and sulphur dioxide is emitted over a wide area, so that the effects are negligible. Stations such as Battersea and Fulham have special plant for flue-gas washing to remove injurious chemicals, soot and grit, and improved methods of stoking are further contributions to a smokeless atmosphere.

Of the two main offenders outside the home producing the grime which affects

clothes and buildings, industry and the railways stand out. In both electricity is providing smokeless motive power which has good results not only for the men and women employed there, but for the home as well. The electrification of collieries and factories of all kinds is reducing the atmospheric pollution in industrial zones where the child mortality is highest, and the electrification of railways has a great contribution to make to travellers and to the unfortunate housewives who live near the track. Apart from avoiding the smuts on washing day, the grime on the curtains, and the dingy appearance of paintwork and stone, electricity in industry means that the workers come home less dirty and their working clothes are more easily handled by their wives and daughters.

Although the country housewife has great benefits from breathing clean air and saving on her laundry bills, it is appalling to realize that atmospheric pollution has baneful effects on crops in agricultural districts for a distance of even 10 miles from a badly affected industrial region. This is an important consideration in these days when home food production is more necessary, and the effect of spoiled crops is seen in increased costs to the family purse.

This leads to more detailed consideration of the effects of atmospheric pollution on the housewife. Firstly, it does much to take the pleasure out of home-making, and to reduce it to a sordid battle with a relentless enemy which saps colour, energy and life itself. There is thus its effect on the housewife as a person, and on each member of the family who tackles his or her daily task with a permanent environmental handicap, and a constant threat to health. There is, however, another menace which smoke pollution presents to the housewife, and her family, and that is via the family living costs, and this, of course, bears more heavily on the townswoman ; although the countrywoman pays her share through overall national costs to meet smoke damage. Ministry of Labour figures for 1940 showed that 6d. more per household per week was necessary in towns than in rural areas to account for additional laundry and cleaning materials. The *Manchester Guardian* in 1950 estimated that smoke damage costs the nation annually £50,000,000. This works out at about 20s. per head per annum. While only about 7s. per head is directly payable by the household for such things as laundry, housecleaning, lighting, doctors' bills, chimney sweeping, the balance helps to swell the rising cost of living, which is in itself a rising cause of anxiety to the housewife. What is more, while we have no option but to pay increased prices for some essential commodities, it would appear worse than stupid to pay additional money and to use additional man and woman power for something which could be avoided.

The individual housewife is very much at the mercy of the community in which she lives in regard to smoke nuisance, but in her own home, by the use of electricity, she can go a long way towards alleviating the deteriorating effects on furnishings and fabrics. The Egerton Report says : " Electrical appliances produce no dust, smoke or sulphur dioxide pollution within the home." There is no need for storage space of any kind when electricity is used for all purposes in the home, and this is an important point of view of today's compressed living space.

The cleanliness of electrical appliances is one of the outstanding characteristics, taking of course for granted their very high efficiency in operation. They create no dirt or fumes in providing facilities for lighting, space heating, water heating, cooking, and refrigeration, while another priceless asset, easily manipulated motive power, affords the best means of getting rid of dust and dirt which has come into the household from extraneous sources over which the housewife has no control. The electric vacuum cleaner is often rated as the housewife's most highly prized household tool, and truly, for with a very small expenditure of current it removes a great part of household drudgery along with the dust, and prolongs the life of the fabric.

The electric washing machine, too, has special advantages in grimy districts which make additional laundry necessary, and today the increasing growth of communal laundry facilities of different kinds in which electricity plays an essential part is a real boon to the hard-pressed woman, and is a factor in combating the effects of smoke nuisance.

Where there's smoke there's fire is often a saying only too true, but where there is electricity there is safety in the home, simplicity and efficiency in operation and cleanliness.

Discussion

D. V. H. Smith (Member) found that there was much of interest and value in the series of papers given to the Conference and had nothing but praise for the earlier ones. He was largely in agreement with the first two of the afternoon's papers but felt that the Conference had had an unfortunate paper to end with and regretted having to comment on it critically.

In his opinion it was desirable to extend our use of electricity, provided it was used *productively*. Contrary to Dame Caroline Haslett, he asserted that the use of electricity for space heating, water heating and cooking was wasteful and uneconomic. Dealing briefly with the matter on three aspects, (1) of efficiency in the use of coal, (2) availability of electricity, and (3) cost, he commented as follows :

Efficiency. The average efficiency of electricity generation was 21.33 per cent. *at the stations*, and of this nearly 15 per cent. was lost in transmission, so that the efficiency, as delivered, was only a fraction over 18 per cent. On the average basis of efficiency, each therm delivered consumed over 50 lb. of coal. The old-fashioned open fire, properly constructed, could do better than that using only 40 lb., whilst some of the new types of grates use only 30 lb. of coal or less ; gas fires could do the job with still less fuel ; and central heating with barely 30 lb.—or one-third of the fuel used by electricity.

To give the Egerton standard of heat in the average Council house of today by electricity would require 10,000 kw.h. per house, which needs $7\frac{1}{2}$ tons of coal to generate, and if cooking by electricity is added another ton and a half is needed, totalling 9 tons per house per year. Where were we to get this coal ?

From the point of view of nuisance abatement, fumes as well as smoke had to be considered, and according to Dr. Crossley, the cost of gas washing plant was equal to 10s. per ton of coal used. There would seem little prospect of extending gas washing beyond the two stations at present equipped.

Availability. Mr. Smith contended that it was not true that the shortage of electricity was caused mainly by increased industrial demands. From publicly supplied electricity little more was being used for industry than in 1943-44, and this was confirmed by Ministry of Fuel and B.E.A. Statistics. The great extension had been on domestic supplies, and due mainly to the heating and cooking load.

To allow the use of all-electric space and water heating and cooking along with other necessary and desirable gadgets would require connected a minimum of 6-8 kw. per house. Such a load on new housing alone would fully absorb all the additional electricity that could be produced for the next ten years or so. Were we to wait all that time for more production from factories and farms ? To apply this load to existing houses would require two to three times the present output.

Coming to the question of cost, Mr. Smith mentioned that some of our towns' new flats had just been erected with all-electric equipment : space heat, water, cooking, and other items. In the Housing Accounts, the capital cost of the heat service would appear very low, probably £40 or £50 per house, but the cost to the country, having allowed for the cost of the generating plant, would be nearer £400 per house, without including the cost of the internal appliances. Considering that such a sum would have built a complete house in pre-war days, it was no wonder that prices were rising. According to the figures contained in the latest B.E.A. report, Mr. Smith gave the cost of operation as £50 per house per year (10,000 units at 1.2d. per unit) which could not compete with the cost of gas and solid fuel, and added that no juggling with tariffs would get rid of this cost.

It was high time that all concerned realized the direction in which the use of electricity for ordinary heat services was leading. It meant higher costs, more coal shortages, and less production all round.

In conclusion, Mr. Smith stated that the application of some simple arithmetic to this absurd claim would soon bring them down to earth and cause us to seek for more practical means to further the interests of the Society.

Eric Bellingham (Director-General, Coal Utilization Joint Council) said there was a growing realization that, whilst gas, electricity and solid fuel each had an important part to play in bringing comfort, amenity and efficiency to the home, the use of solid fuel for basic space and water heating was for many years likely to be the normal and most economical

way of heating space and water in the homes of the great majority of the householders of Great Britain.

He suggested that the only justification for using coal in power stations at an efficiency on to busbars of only slightly more than 20 per cent. was the vital need to increase the availability of electricity in the factories and workshops of the country. As a source of heat for domestic space and water heating, electricity should in the national interest remain a near luxury and therefore an expensive way of space and water heating. This was the really effective way to ensure that the domestic demand should not come to the peak.

The Coal Utilization Joint Council believed that the more efficient use of bituminous coal in modern appliances was a more practicable way of reducing the discharge of smoke by the domestic chimney than trying to replace 30 million tons of bituminous coal by solid smokeless fuel that could not possibly be available in sufficient quantity during the period originally estimated in the Simon Report.

James H. Orr (Coalite and Chemical Products Limited) said that whilst it was desirable to urge the installation of new and more efficient appliances, they should be very careful and not infer that solid smokeless fuel could only be burned in special grates. This was not true, as any existing grate without addition or alteration successfully burned solid smokeless fuel such as low temperature coke. The term low temperature coke was very misleading as it was, in fact, a very high temperature coke. The housewife had no difficulty in identifying the source of supply of gas coke, gas and electricity and as Phurnacite was now mentioned by name he considered the time had arrived to discontinue the general term low temperature coke and say Coalite, Rexco, etc.

Dr. F. J. Eaton (Institution of Gas Engineers) said he had noted recently that many responsible and influential members of the coal industry were attacking the Simon Report. Mrs. Fraser-Stephen in presenting her paper this afternoon had called the Simon Report " utopian " and has led them to believe that it is impracticable and unrealistic. As time was short he would confine his remarks to an examination of these points. Let them first of all see what the relevant section of the Simon Report had to say. He quoted from Chapter XIII headed " Smoke Abatement," and paragraph 2 :

" Smoke is due to the burning of bituminous coal. Our two main lines of reform are :

" (*a*) To replace bituminous coal by smokeless fuels : smokeless solid fuel, gas or electricity. If and when that process is completed domestic smoke will be abolished. Meanwhile, we have recommended that the available surplus of smokeless solid fuels shall be mainly absorbed in the new houses. Comparatively small amounts will therefore be available for increased use in existing houses. These problems have already been fully dealt with in earlier sections of the report and there is no need to discuss them further here.

" (*b*) The process must necessarily be a slow one ; we have estimated that it will not be possible to produce the necessary amount of smokeless solid fuels for twenty, or perhaps thirty years. Our second main line of reform is therefore to install improved appliances to burn bituminous coal with the minimum of smoke."

As a long term programme (page 35, paragraph 11), a target of 20 years was set for the completion of the change-over, i.e., an increase of one million tons of solid smokeless fuels per annum, but the 30 year period seemed a possibility even in 1946, and this would involve an annual increase of 650,000 tons. To carry out this programme it would be necessary to divert coke from industrial to domestic markets, a step already being taken by the gas industry, and to increase the availability of anthracite and Welsh dry steam coals. The President in her address had stated that between a quarter and a fifth of the gas coke found its way to the domestic market. This figure was for the country as a whole, for the London area the figure was more nearly one-third. This shift to domestic markets was arrested at present because of the fuel needs of industry, but in spite of this the increased production of gas coke of 250,000 tons per annum was well able to keep pace with the requirements of new houses equipped with improved appliances. There were, they knew, many such appliances on which coke was not being burned. He believed the true reason for this was that because of the big reduction of coal allocated to the domestic market (a drop of 15½ million tons in 9 years—Ministry of Fuel and Power Statistical Digest, 1948-49, Table 66) many house-

holders were burning mixtures of coal and coke on old appliances primarily intended for coal burning. The problem was one of distribution not supplies.

Dr. Eaton then directed attention to two most important sections of the Simon Report which were eminently practical and which had been adopted and put into practice. First there was the recommendation about improved appliances (Chapter XV, 2), which had led to the setting up of the Ministry testing and approval organization, so that in new housing they were assured of efficient appliances; and secondly, the recommendations on research on house heating found practical form in the fundamental work of the heating of houses carried on by the Building Research Station at Abbots Langley. He did not suppose his coal friends would agree that smokeless zones were practical. Such zones, however, were being developed in many parts of the country. For the domestic appliances in such zones, it would be necessary to burn smokeless solid fuels and he was authorized to say that supplies of these fuels would be made available to the smokeless zones now contemplated.

In conclusion, he said that the Simon Report set out a domestic fuel policy. They needed such a policy today; the population was spreading over an increasing number of individual homes, all of which had to be heated and there was less fuel available to meet the demand. The answer lay in more efficient appliances and more efficient heat utilization, and in this development all fuels must be considered and play their part. To meet the needs of the domestic market appliances must be capable of burning all solid fuels efficiently and so far as bituminous coal was concerned, it should be burned smokelessly. At present there was only one domestic appliance which would do this.

G. W. Farquharson (Midlands Joint Council for Smoke Abatement and Atmospheric Pollution) said that the replacement of out-of-date existing domestic fire grates by modern approved appliances, whilst recognised to be a necessary factor towards national fuel economy and smoke abatement, was mainly a matter of persuasion rather than compulsion. It was left to salesmanship technique on behalf of the many interests concerned to convince the tenant of domestic houses of the benefits gained. Amongst these interested parties the local authority official could play an important part.

Mrs. Fraser-Stephen had mentioned the Housing Act, 1949, in her opening remarks and suggested that this Act could be used by more people. It was his view that the limitations and conditions laid down in the Act would have to be altered and he would like the speaker's opinion on whether she agreed that if the conditions for an application for an improvement grant were reduced to £30 instead of £100 that this would be an incentive for more people to consider the conversion of the old-fashioned fire grates. The Domestic Fuel Policy, commonly known as the Simon Report, was issued in 1946 and he felt the Ministry of Fuel and Power missed a splendid opportunity in the preliminary drafting of the Housing Act, 1949, in not using their influence to have the £100 limit for improvement loans lowered to suit the case of domestic grate improvements.

He would also like the speaker's opinion on the use of the term "owner-occupier" in reference to the applications for grants. He suggested that the expression "owner" would have broadened the field and included the types of houses where improvements in fire grates were most needed.

They must be practical and recognize solid fuel was the main fuel in use, and he endorsed the remarks by the speaker that the down-draught type of fire grate had a promising future.

John Fox (Member) said that the three Papers presented were wholly admirable from the point of view of the housewife. They were entirely complementary one to another, and each demonstrated the contribution which could be made towards obtaining a cleaner atmosphere by the intelligent use of solid fuel, gas and electricity respectively, either alone, or by various combinations of all three.

He was very glad that reference had been made to the down-draught principle which offered great possibilities, but no mention had been made of some of the highly efficient hopper type boilers, such as the Cokette, Trianco and Brockhouse. It was true that some of these were selective in their fuel requirements, and some also required a small electric fan, but the latter was not a serious handicap in urban areas, assuming that the fuel was available, difficulties with storage would seem to militate against the use of solid fuel in many flats.

The desirability of chimneys for ventilating purposes had been emphasized by

Miss Lovell Burgess and attention drawn by her to the gas convector fire. The so-called Vectair system operated on the same principle, but was used in conjunction with steam or hot water pipes. This was a sound proposition when used in conjunction with an efficient boiler, possibly mechanically-fired.

References to the national fuel resources had been made in each of the afternoon papers. The subject of fuel economy was intimately tied up with smoke abatement, and according to all forecasts the winter was likely to be as cold and dark as the early months of 1947. Moreover, they must expect this sort of thing for years to come and an indefinite postponement of all the good things suggested in the Simon Report. An increase of 0.1 per cent. thermal efficiency at B.E.A. generating stations as mentioned in Dame Caroline Haslett's Paper would not go very far in this respect.

The one major source of energy in this country was coal, and it would remain so for many years to come. Sir Claude Gibb recently stated that the average efficiency of utilization is only 15 per cent. and until some sound fuel policy was formulated and put into practice, there was little hope of any appreciable improvement. All purchasers of coal were making some attempt to use it more efficiently, sometimes only because the price was so high, particularly in industry, but how often was any serious thought given to the important matter of conserving this great national asset ?

It might not be easy for individuals to find the cash to purchase modern heating appliances for their homes, and although he disliked the principle of the hire-purchase system, it must be conceded that a very sensible view was taken in the Manchester Corporation Act of 1946. Hire purchase could certainly help to achieve these aims.

Direct domestic consumption accounted for about 30 million tons of bituminous coal, and a total of just under 40 million tons of solid fuel at an overall efficiency of slightly better than 10 per cent. But what about the 180 odd million tons of all classes consumed by the nationalized gas, electricity and railway undertakings ? The last was a particularly bad offender as regards atmospheric pollution.

Sir Claude Gibb had suggested that these three great industries be integrated with the coal industry, so that together they could face the enormous capital expenditure which will be necessary over the next fifty years. By so doing, it was almost certain that the same amount of heat, power and light could be obtained from 120 million tons of coal as was now obtained from about 200 million tons. In confirmation of this, Oliver Lyle, in his Paper " Inefficiency," presented to the Institute of Fuel a few years ago, suggested that on technical grounds some 80 million tons of coal could be saved annually in this country. Be that as it may, it was likely that before the century was out, we should only be raising about 120 million tons per year in any case, and, moreover, with the present rate of increase in demand, chiefly domestic for electricity, the B.E.A. coal consumption would increase by 40 per cent. in the next ten years. And it must be remembered that the large B.E.A. power stations which were being built today had an economic life of thirty years. It was doubtful whether any of them will touch 30 per cent. thermal efficiency at the busbars. So much for electricity, but with the proviso that if gas turbines could be made to burn a far wider range of fuels than at present the position might well be improved. There is also considerable scope for thermal electric stations, with district heating, such as the Battersea-Pimlico scheme, now nearly completed but only on a small scale—while the City of Manchester plan had catered for such possibilities. Thermal efficiencies of 55 or 60 per cent., or even more, could be expected under such conditions. Mr. A. Stubbs developed this subject in a Paper on District Heating before the Institution of Mechanical Engineers in April, 1948.

Gas heating could readily achieve a coal utilization efficiency of 60 per cent. and owing to the storage of gas in gas-holders, no peak loads need be met in the retort house, while at the same time valuable by-products were obtained in the manufacturing process.

There was a case for night electric hot water storage, as then the generating plants are lightly loaded, but radiators of the open bar type were skockingly extravagant, and should be banned for day-time use, as well as the open domestic coal fire. Mr. Lyle suggested that an excise duty on coal amounting to £7 per ton would help to kill such abuses, but the implications of such a scheme were far too complex to be imposed with a light heart.

Had the coal used for domestic consumption in 1947 been properly processed, 100 million gallons of benzole, 660

million gallons of crude tar, 25 per cent. of the national spirit and oil requirements, the latter used with the benzole, and over 1,000 million therms in the form of gas, totalling 50 million pounds sterling in value, could have been obtained. The quantity of gas quoted was roughly one-third of Britain's consumption for that year.

Sir Claude Gibb's proposals for the future were printed in the *Engineer* for June 1st, 1951. Mr. Oliver Lyle's Paper, "Inefficiency," was read before the Institute of Fuel in March, 1946, while Dr. Foxwell also put forward some interesting proposals in a Paper to the same Institute several years ago.

C. A. Stansbury (Chief Sanitary Inspector, Walsall) said that they had listened this afternoon to an outstanding contribution by the ladies on this problem and he appealed to the ladies present and to all women's organizations to take this matter of smoke prevention and the efficient use of the nation's fuel resources seriously.

He was of the opinion that women had been rather frightened of the technicalities of fuel efficiency and if they would look at this problem in the light of the hard work and drudgery that they have to put up with in their homes in maintaining old-fashioned fuel appliances, he was certain that progress in this field would be very much quicker and much more effective than it had been in recent years.

W. R. T. Skinner (South-Eastern Electricity Board) said that so much had been said at the conference which seems to imply that there were many who regarded electricity for space heating as the "bad boy" of the family, that he felt compelled to pose the question at once: "Surely the use of electricity for space heating was recognized as at least a *possible* means by which the purpose of the Society—namely, the abatement of smoke—could be achieved and achieved effectively?" As a practical means to the end which the Society sought, it ought not to be dismissed from consideration merely because someone had views on thermal efficiency or on some other extraneous and, for this purpose, irrelevant characteristic. The fact was, that electricity provided a smokeless way of space heating, whatever the rights and wrongs of it might be from points of view other than the point of view of this Society.

They heard a great deal nowadays about the need for a "fuel policy," as if behind this easy generalization lay the simple answers to many of the complex basic troubles of today. Let them consider for a moment what was meant by this phrase "a fuel *policy*." As he saw it, it could only mean what some person, or some group of people, in the light of present knowledge and experience and in the light of present methods and techniques, reinforced perhaps by what might be assumed to be foreseeably developed in the future, thought would be the best way of getting all the services they want out of such fuels and sources of energy as were available. But even if anyone could be found who was courageous enough to formulate such a policy it would be more than likely that in the circumstances of 5, 10 or 15 years' time that policy would be seen to be wrong, or at least not the best. Thus, the only result of adopting the earlier "policy" (assuming that its adoption meant action) would be extension of the area over which the wrong thing had been done, and the consequent retardation of progress towards the ultimate goal.

Such a policy certainly could not be based on anything so simple as thermal efficiency, if only for the reason that there were many classes and ranks of coal, many of which were not readily interchangeable for one another for the purpose of a particular process. For instance, he suspected that much of the coal burnt in electric power stations today would not be very welcome in most domestic grates, nor in a gasworks, however attractive might be the thought of the possible extraction of by-products. With the working of progressively poorer seams of coal and the advance of machine mining it might well be that the proportion of such coals as power stations are equipped to burn with high efficiency would increase as time went on in relation to the total production of the mines.

Surely the Society would be well advised to encourage simultaneously *all* methods of achieving its object, leaving to consumer choice, relative cost or other pertinent factor, the determination from year to year, of an approximation to the best compromise amongst all the available methods. Such a widespread choice would be bound to reflect to some extent the sources of supply and the advances of technique ruling at the time. Only thus, it seemed to him—only by stimulating all possible competition while avoiding the heavy risk of making some widespread

mistake by the too-easy formulation of a "policy," which, almost by definition, would be "restrictive" in outlook—could the Society hope to achieve its object in the shortest possible time. No one method at present known could find the whole solution of the smoke problem within measurable time. Why not, then, encourage all to "have a go"?

Authors' Replies

Mrs. Fraser-Stephen said that she felt encouraged by the kind reception given to her paper, especially since the views of her organization were not entirely in line with those of the Society. There appeared to be only three points in the discussion which she felt she should try to meet.

In connection with Mr. Orr's point, she would like to add that in view of the present smokeless fuel situation, she felt it desirable that anyone selling modern appliances which would burn all types of fuel including coal, "Coalite," etc., should make this clear to the customer. Admittedly smokelessness and thermal efficiency would be lower with coal than with coke, but it would still be better to use one of these appliances rather than the old-fashioned open fire. Multi-fuel appliances should not be shown, as they were by some gas undertakings, surrounded by display material implying that these fires could be fuelled with coke only.

Dr. Eaton had suggested that it was unfair to call the Simon Report "Utopian." In her paper she had attached this adjective to one point only of the Simon Report, namely, the suggestion that the amount of smokeless fuel necessary to replace all domestic bituminous coal could be achieved in 20 years. Now—since five years had passed since the Report was issued—this period would be 15 years. In spite of Dr. Eaton's remarks, she still felt that this view was Utopian, particularly when one considered the natural shortage of suitable coals, and the enormous capital cost of plant. In other respects, she agreed with him that the Report had inspired an immense amount of good work.

Mrs. Fraser-Stephen agreed with Mr. Farquharson's point that to lower the minimum for applications for improvement grant to £30 would be an incentive to replace obsolete appliances. Although she would hesitate to criticize those in authority, it really looked as if the Act was being administered in such a way as to render it useless for improving those very conditions for which it had been advertised as a remedy. Regarding the point about "owner-occupiers," the—somewhat elusive—benefits of the Act were extended to landlords as well, but with strict limitations both on rent and on the percentage recoverable from the tenant. She felt that the best thing for the landlord would be revision of the Rent Restriction Acts, to allow for a reasonable return to the landlord on money spent for repairs and improvements. The Treasury attitude towards the financing of easy payment schemes, and the complexities of the law of Landlord and Tenant regarding fixtures, were other obstacles preventing many people from installing efficient and smoke-reducing appliances. Yet these difficulties were largely administrative, and could be solved by hard thinking and concerted action. She ventured to suggest that as an immediate task the Society might devote its admirable crusading spirit to getting these obstacles removed.

Miss Lovell Burgess said that the Conference in general, and the women's session more particularly, had brought home to her the need for gas, electricity and coke to be complementary rather than competitive. She would like to underline the observation made in her paper that certain fuels were best fitted to do specific tasks.

From an overall, national viewpoint the long-term use of derived, or secondary, fuels was in various ways less costly than the burning of raw coal—this was particularly true of gas, because of the by-products, including coke, which, incidentally, needed gas for its speedy ignition—while from the point of view of smoke abatement the use, in industry and in the home, of secondary fuels in place of bituminous coal would achieve the Society's object.

Miss Norvick (for Dame Caroline Haslett) referred to the fact that the electrical contribution appeared to have drawn most of the fire. Mr. Smith and other gas speakers seemed to be much more concerned with economics than with hygiene in spite of the fact that the purpose of the session was to discuss "smoke prevention *in* the home."

On the latter there was no gainsaying that electricity alone provided the complete solution. On the former issue, and indeed in the latter also, she was most grateful to Mr. Skinner who she thought had very succinctly dealt with the criticisms and introduced a more realistic note

into the discussion.

In her paper Dame Caroline had presented an entirely positive case : it was unthinkable that millions of users of electric cookers and water heaters would willingly return to less clean and more laborious methods ; she was satisfied that freedom of choice and more plant at the power stations would not only prevent putting the clock back but would also do much to advance the objects of the Society.

RESOLUTIONS

At the closing session of the Conference the following resolutions were proposed, on behalf of the Executive Council, and were unanimously agreed.

1. THAT this Conference of the National Smoke Abatement Society expresses appreciation of the action of the Government in ensuring that approved fuel-burning appliances only are installed in houses built either by local authorities or by private builders under licence, and, as a further step towards fuel saving and smoke abatement, the Conference urges the prohibition or active discouragement of the manufacture and sale of appliances that do not meet minimum standards of efficiency. Further, whereas the increase in value of premises is normally followed by increased assessment, the fuel situation is so serious that the Conference urges that the modernization of heating equipment should be treated exceptionally and urges that, on the contrary, financial or other inducements should be given to obtain this end.

2. THAT this Conference of the National Smoke Abatement Society urges all local authorities and industrial firms and associations to promote smoke abatement and fuel efficiency by assisting in and encouraging the organization of classes for boiler and furnace men and attendance at them of the men concerned.

3. THAT this Conference of the National Smoke Abatement Society invites Chambers of Commerce and other business and industrial associations to consider the cost and waste to trade and industry caused by air pollution, and asks them to bring this to the notice of their members with a view to greater co-operation for the prevention of pollution with local authorities and the Society and its Divisions. The Conference records its appreciation of a recent resolution of the National Union of Manufacturers that called for economy in the use of fuel, further research, and the extended use of smokeless fuels.

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The Society's Publications

This is one of the many publications of the National Smoke Abatement Society. For a complete list write to the Society for its current Year Book. This contains a Guide to Publications on Smoke Prevention and Allied Subjects, which includes, in addition to the Society's own titles, particulars of other books, reports and papers, any of which may be purchased from the Society. The list is classified according to subject—the Law, Conference Proceedings, General, Historical, Smoke Prevention Administration, Industrial Smoke, Domestic Heating, Technical and Scientific, and Industrial Pollution.

NATIONAL SMOKE ABATEMENT SOCIETY

Proceedings of the 19th Annual Conference, Portsmouth

24th to 26th September, 1952

Chandos House, Buckingham Gate, London, S.W.1

CONTENTS

Portsmouth Conference

SUMMARY OF EVENTS

The delegates were welcomed and the Conference officially opened by the Right Worshipful the Lord Mayor of Portsmouth (Alderman Albert Johnson) on the morning of Wednesday, 24th September. Then followed the Presidential Address by Alderman Professor F. E. Tylecote, for which the Lord Mayor kindly remained as Chairman of the meeting.

On the afternoon of the same day Mr. W. R. Hornby Steer, Barrister-at-Law and Standing Counsel to the Society, delivered the 3rd Des Voeux Memorial Lecture—Smoke and the Law. The Chairman of the Executive Council, Mr. S. N. Duguid, was in the Chair. During the evening delegates and their friends were guests of the Lord Mayor at a Civic Reception and Ball.

On Thursday morning, 25th September, the session on Progress Reports was under the Chairmanship of Alderman J. Chapman. The reports included contributions by various authors on Air Pollution and Cancer of the Lung, Prior Approval, Smokeless Zones and other Developments in the Prevention of Domestic Smoke, Report from the U.S.A., Review of Fuel Research Station Investigations on Atmospheric Pollution, and Local Joint Consultative Committees.

Incentives for the Prevention of Air Pollution was the subject of the afternoon session, and the two papers gave the industrial and the domestic points of view. The Chairman for the session was Councillor F. Miles, of Portsmouth. Two resolutions, which are set out at the end of these Proceedings, were brought before the Conference and approved. One further resolution, moved on behalf of the Executive Council, urging that Coronation Day should be smokeless, was not carried. An Evening Party was held at the Royal Beach Hotel attended by guests and members of the Society.

The last paper of the Conference was given on Friday morning by Professor R. J. Sarjant, of Sheffield University, on Pollution Problems in the Iron and Steel Industry, with Sir Ernest Smith, Hon. Treasurer, in the Chair. The Annual General Meeting of the Society immediately followed this paper with Mr. S. N. Duguid as Chairman.

The authors and sessional Chairmen were particularly mentioned in the vote of thanks proposed by Mr. F. J. Redstone at the conclusion of the Conference. Also included in the vote of thanks were the Lord Mayor of Portsmouth and the members of the City Council, Mr. W. F. Appleton and the members of his staff, Mr. David Evans and the staff of the South Parade Pier, Mr. A. Kinnear, General Manager of the Entertainments Department, the Chairman and members of the Conference Committee, and the staff.

On Friday afternoon a large party of delegates visited H.M.S. *Victory* and H.M. Dockyard, and at various times during the period of the Conference delegates paid visits to the Sewage Outfall Station to inspect one of the very few Beam Engines still in use.

PRESIDENTIAL ADDRESS

by

Alderman Professor Frank E. Tylecote
M.D., D.P.H., F.R.C.P.Lond., J.P.

Mr. Chairman, Ladies and Gentlemen. I must first of all express my gratitude for, and appreciation of, the honour you conferred upon me last year in electing me as your President. It came as a great surprise to me, and I regard it as much a compliment to my adopted city as to myself. For, as you know, Manchester was the cradle or one of the two cradles of the Society, as it was there that the Smoke Abatement League of Great Britain was founded in 1909, which amalgamated in 1929 with the Coal Smoke Abatement Society of London to form this Society. Following the injunction of the prophet, I propose in this short presidential address to first of all praise famous men, or at any rate to give some account of some of those fathers which begat us limiting myself to those who have passed on, and then to refer briefly to one or two topical matters.

In 1603 a Sir Hugh Platt (1552-1611), a versatile as well as a wealthy man, produced a form of briquette designed to lessen the evils of coal-smoke: this he described in a pamphlet under this title, *A new cheap and delicate fire of coal-balles, wherein Sea-cole is by the mixture of other combustible bodies, both sweetened and multiplied.* His " ball " consisted of two parts of sea-cole, and one part of small coal, sawdust, or other suitable material moulded by hand with a paste of thin loam and water into a ball. Sir Hugh's main love was agriculture and gardening, but he also wrote on cooking—in this he was not alone amongst the male sex of those days—and he published a recipe for dyeing the hair!

But our most eminent pioneer was without doubt John Evelyn, best known perhaps as the diarist, but amongst many other works the author of *Sylva*, a standard work on trees, the title of which later became the author's nickname. He lived from 1620 to 1706, being born and buried at Wotton, or Wooton, in Surrey. He only succeeded to the family estate at Wotton twelve years before his death and for a large portion of his life (1653-94) lived at Sayes Court, Deptford where he laid out famous gardens and where his nine children were born. His wife was Mary Browne, daughter of Sir Richard Browne, the British Ambassador in Paris. He first met her when on a continental tour and they were married when she was only twelve years old, her first child—most of the nine died of smallpox (Jenner announced his discovery of vaccination in 1798)—being born when she was 17. To show that there was no objection to such early marriages in those days I mention that Dr. John Earle, an eminent divine who was afterwards Bishop of Salisbury, went over to France to marry them in the Ambassador's Private Chapel at the Embassy.

There are many other instances of such youthful marriages, such as that of the Miss Davies, who at the age of eleven married the Grosvenor who is regarded as the founder of the Westminster line, and of Elizabeth Percy, daughter of the Earl of Northumberland, and the richest heiress in England, who was twice widowed at the age of fifteen.

In 1660 the Royal Society was definitely constituted, and Evelyn with Robert Boyle, Christopher Wren, and others were amongst its first members and members of the Council. He became its secretary in 1672 and in 1690 was offered

the Presidency, which he declined. That work of his which established him in *our* estimation was first published in 1661, a tract or pamphlet called *Fumifugium or the Smoake of London Dissipated*, which was and is, as Mr. Marsh has called it in his well-known work " that most brilliant indictment of London Smoke." It was dedicated to Charles II (our hero was a great royalist and a personal friend one might almost say). Charles, as was his wont, promised to do great things and never did them, and his promises regarding smoke abatement made to Evelyn were no exception to the rule. As this work had become very scarce indeed we, that is, the Society, published a new edition of it in 1933. This edition is still procurable at the Office, price 1s. 6d., and has an interesting preface by Rose Macaulay, as well as a woodcut from Sir Godfrey Kneller's well-known portrait of Evelyn as a frontispiece. Kneller lived 1646-1723 and the portrait is said to be *c*.1689.

At the time when *Fumifugium* was written the siege of Newcastle was still in everyone's mind; it had taken place only in 1644 and had lasted 16 weeks. Most of London's coal came from there and was therefore called sea-coale—hence Sea-coale Lane in the city and the phrase " send coals to Newcastle." So Evelyn's reference to the gardens and orchards in the heart of London in the year of the siege being much more luxuriant and better in leaf and in fruit than in other years is very apt and topical. (In this regard it is interesting to recall that the then Lord Mayor of London in 1886, when the Smoke Abatement Institution of that time had its great Mansion House meeting, drew attention to the comparative absence of smoke in the city at the week-end). But Evelyn's remark is important as being one of the earliest references to damage to vegetation caused by smoke. Similarly important is the history of the London merchant who came into his office in the City and after a short time found himself unable to breathe, so got on his horse—ready saddled at his office door—and hastened back to his home in the country. This is probably one of the earliest records of allergic asthma.

But I must give some extracts in Evelyn's own words. The first is taken from his great diary and is dated July 11th, 1656. " Came home via Greenwich Ferry where I saw Sir John Winter's new project of charring sea-coale, to burn out the sulphure and render it sweet." The quotations that follow are from *Fumifugium*.

i. For Diseases proceed not from so long a series of causes as we are apt to conceive, but most times from those obvious and despicable mischiefs which yet we take lesse notice of, because they are familiar; But how frequently do we hear men say (speaking of some deceased neighbour or friend), He went up to London, and took a great cold, etc., which he could never afterwards CLAW off again.

ii. That this glorious and antient city, which from wood might be rendered brick and (like another Rome) from brick made stone and marble; which commands the proud ocean to the Indies, and reaches the farthest Antipodes, should wrap her stately head in Clowds of Smoake and Sulphur, so full of stink and darknesse, I deplore with just indignation.

iii. But I will infer that if this goody city justly challenges what is her due, and merits all that can be said to re-inforce her praises and give her title; she is to be relieved from that which darkens and eclipses all her other attributes. And what is all this, but that Hellish and dismal Cloud of SEA-COALE? which is not only perpetually imminent over her head, but so universally mixed with the otherwise wholesome and excellent aer, that her inhabitants breathe nothing but an impure and thick mist, accompanied with a fuliginous and filthy vapour, which renders them obnoxious to a thousand inconveniences, corrupting the Lungs and disordering the entire habits of their bodies, so that Catarrhs, Phthisicks, Coughs and Consumption range more in this city than in the whole earth besides.

iv. I propose therefore, that by an act of this present Parliament this infernal nuisance be reformed; enjoyning that all these works be removed five or six miles distant from London below the river of Thames.

v. (the aer of London) not to be parallelled in any place of Europe, save the Grotto del Cane, nere Naples, the os plutonium of Silvius, or some such subterranean habitation.

Enough has now been said to indicate what smoke abatement owes to John Evelyn, but we can hardly leave him here.

We must try to indicate his versatility, because his fame, like that of Leonardo da Vinci, rests on so many different talents. Apart from his great diary (second only in importance to that of Pepys, who was by the way President of the Royal Society in 1684 when Evelyn was still secretary), yet not published till over a hundred years after his death, he wrote *Sylva* and *Terra*, and many works of a lesser nature, e.g., on medals, engraving, landscape gardening, and architecture, as well as on religious subjects, and translations of classical Greek and Latin works. A traveller, a royalist, a deeply religious man, yet capable of a sincere and unsullied friendship with a very young woman, Margaret Blagge a maid of honour at Court, who became Mrs. Godolphin and who died when only 26 years old of puerperal fever. This friendship must be studied closely in the books about her, if one is to understand it, but lest a wrong impression be left here it should be stated that Mrs. Evelyn approved it and she was Mrs. Godolphin's friend. In 1685-6-7 Evelyn was a Commissioner for the Privy Seal.

But why should he, almost alone amongst all of his time, be interested in the evils of smoke? There are dozens of indications that he was a very sensitive man, but surely his appreciation of beauty and his sensitiveness were quickened—as in the case of many famous artists—by his long continental tour, and a glimpse of the scenes, shades and colours of the Mediterranean littoral.

Lastly, we may record here the inscription on Evelyn's tomb at Wotton as follows:

Living in an age of extraordinary events and revolutions he had learned from thence this truth, which he desired might thus be communicated to posterity:

THAT ALL IS VANITY WHICH IS NOT HONEST: AND THAT THERE IS NO SOLID WISDOM BUT IN REAL PIETY.

Thanks to the kindness of Colonel Cousin I had the opportunity the other day of visiting the lovely part of central Surrey in which is situated the Evelyn family seat. One has to remember that although John Evelyn was born and died there, he did not personally enter into possession until a few years before his death. The house, Wotton Place, near Dorking, is now the central training station of the Fire Service. A large part of the original building still stands, though much has been added. The terraced garden behind the house, which Evelyn planned, is now vastly overgrown, but the surroundings are most attractive, and the beauty and tranquillity of the district must have provided an ideal environment for meditation and philosophic thought. The church, unfortunately, was locked, so we could not see the family tombs, although many more modern Evelyn graves are to be found in the churchyard, to which they add taste without pretension. Because of this visit I feel that I now have a much better picture of the man and of his ideas.

Passing from Evelyn with regret, owing to the lack of further time, we must next mention that one Thomas Owen in 1595 brought smokeless fuel and anthracite from South Wales to London in order to help to rid London of smoke. Of some interest too are the facts that Queen Eleanor in 1257 had to leave Nottingham for Tutbury because she could not stand Nottingham's smoke, and in 1578 Queen Elizabeth was so troubled by London's smoke that the Westminster brewers offered to burn wood in their brewhouses.

Timothy Nourse

We now come to our second real pioneer, one "Timothy Nourse, Gentn." as the title page of his tract *Campania Foelix* describes him. This pamphlet was published posthumously in 1700—he died in 1699, and there is a copy in the Guildhall Library. He was an Oxford Graduate and a fellow of University College who also wrote on religion and husbandry; he became a Roman Catholic convert in 1672. The subtitle of this work is *A Discourse on the Fuel of London*. Here he covers to some extent the same ground as Evelyn covers in *Fumifugium*, but (after proving that the average number of chimneys to a London house is nine!), he describes also the ravages which smoke causes in indoor furnishings, tapestries, etc., and the need to use wainscoting to replace tapestries.

I now give two extracts from this work:

i. "A bed of fourscore or one hundred pounds price, after a dozen years or so, must be laid aside as sullied by the Smoake which in the country might have been preserved fresh, and in its primitive lustre, for many ages. All forms of hangings, especially tapestry, are in a few years totally defiled by it, and STINKING RICHLEY into the bargain, as may

be seen or smelt rather in all the hangings almost of ordinary houses. Hence it is, that of latter years, they choose rather to make use of wainscot to line their walls with, though this too is quickly found to lose its beauty. All . . . suffer extreamely by this tartanous smoake . . . persons in their apparell . . . hats, periwigs silks turn russet and lose their beauty."

He then refers to the smoake getting between the mortar and discolouring buildings, and especially St. Pauls, now in building, "which might have been convenient if the outside had been of plainer mould." For remedy the use of wood and charcoal is discussed and the question posed—Is the quantity available sufficient? Is the profit and benefit we should obtain greater than the damage we suffer by the use of sea-coale?

ii. For whilst sea-coale is burnt in so great a quantity (as) it is at present, shopkeepers must expect to have their wares tarnished and sullied, which must debase the price, let them do the best they can. The Citizens and Gentlemen must have their rich furniture smutted and casted and their closer rooms stinking and smoky. Their wearing apparel likewise must be subject to the same fate and everything lose its lustre. The Skins and Complexions, especially of the fairer sex will stand in constant need of artificial helps, which in time bring Nature under inconceivable decays and deformity. The Buildings, whether public or private must run the like destiny, whilst their streets are continually dirty and stinking and the town itself perpetually plagued with coal dust and rubbish. The inhabitants must be contented frequently to want the sun for many days together, and especially in season when its Beams would be most welcome, as also to have their bodies filled with coughs and rheums, till they fall under consumptions. All the innocent contents which the mind can take from fair prospects, whether of buildings, or of the country, are lost in these clouds; all the beauties and verdure of gardens are blackened by this sooty air; all the roads and walks near the city being continually subject to black stinking dirt or dust, and from this stinking and smoaky air it is, probably, that young infants are hardly to be bred up in London; for their new-born bodies, like tender plants or blossoms, are soon blasted by the Sulphureous Exhalation."

Franklin and Thompson

Passing over another 60 odd years we come to several lesser contributors, first of all Benjamin Franklin (1706-90) an American Statesman and author who, sent to London by his Pennsylvania Assembly, made friends with Matthew Bouton, later partner with James Watt, to whom he wrote as follows:

"I would only repeat to you the hint I gave of fixing your grate in such a manner as to burn all your smoke. I think a great deal of fuel would then be saved, for two reasons. One that smoke is fuel and is wasted when it escapes unflamed. The other that it forms a sooty crust on the bottom of the boiler, which crust, not being a good conductor of heat, and preventing flame and hot air coming into immediate contact with the vessel, lessens their effect in giving heat to the water. All that is necessary is to make the smoke of fresh coals pass descending through those that are already thoroughly ignited."

To this period also belongs the American Benjamin Thompson, later Sir Benjamin Thompson, who founded in 1799 the Royal Institution, which remains his permanent monument. He lived from 1753 to 1814, devoted his life to scientific pursuits, and was created Count von Rumford by the Elector of Bavaria in 1794. He invented the paragon mirror, smokeless (or smoke-reducing) grates (Rumford's fireplaces), a concealed kitchen, smokeless chimneys, and so on; and announced that with the smoke which was wasted in London he could warm every house and cook the food for the entire population.

Apparently another American interested in smoke was the great Abraham Lincoln, for it is recorded that on 26th October, 1864, he wrote to J. R. Underwood as follows: ". . . holding these smoky localities responsible for the conflagrations within them has a very salutary effect."

Modern Days

We now come to more modern days and to the names in the records of the London league (or to give it its proper name, the Coal Smoke Abatement Society)—Sir William Richmond, R.A., Harold Antoine Des Voeux, Sir Lawrence Chubb, and Dr. J. S. Owens, all of whom have "passed on." Others are still with us, and before going further, as regards

both London and Manchester, I wish to say that I have found it impossible even to mention those who are carrying the torch today—I leave it for future holders of my office to deal adequately with them —and have felt it to be unfair to single out names from among those whose work is as yet unfinished. Preserving this line of demarcation one notes among the Manchester names those of Millicent Jast, Will Melland, our beloved late President, and Charles Gandy, our late Chairman, who I doubt not would have been filling my office today, and so much better than I can, were he still alive. There are also Scotland's pioneers, and mention must be made of their leader for many years, Bailie William Brownhill Smith.

Des Voeux lived from 1861 to 1942. He was the first Treasurer of the London Society and had Sir William Richmond as his first President. He later became himself the first President of the new National Smoke Abatement Society. He was for many years a member of the Westminster City Council, and found it a useful platform for his pioneer work—a fact which might well be taken as a hint by others of us similarly privileged. I would not deny that pioneer work requires also much time for thought, or that aptitude for original work which is not given to everyone, especially to older people; but a sense of dissatisfaction with the *status quo* may be the prelude to many valuable ideas.

Des Voeux's influence led to the prosecution of offenders, to the appointment of the first smoke inspector, and later in 1899 to the formation of the Coal Smoke Abatement Society and to the passing (here Chubb was associated with him) of the Public Health (Smoke Abatement) Act, 1926, later incorporated with the Public Health Act, 1936.

Though he experimented with gas fires, cookers, grates, etc., so constructed as to improve heating and lessen smoke yet he and Chubb had their livings to make in their professions and the lack of more time to devote to smoke abatement nearly led to the movement dying out—a position which was saved by Manchester joining up. The first conference was held at Buxton in 1929 with 34 members present. Des Voeux was still President of the National Smoke Abatement Society when he died in 1942. One notes that Chubb was founder, and until his death, secretary, of the Commons and Footpaths Preservation Society.

Smokeless Zones

I now wish to refer to two topical subjects. Firstly, Smokeless Zones. It was in this field that much of the pioneer work of our much esteemed and deeply-lamented Chairman, Charles Gandy, was done. But one has to recognize a disease before one can apply a remedy. In 1935 he first mooted the idea at a meeting of the Manchester and District Branch of the Society. In 1936 the omnibus Manchester Corporation Act contained authority for the first smokeless zone—in the centre of the city. On May 1st of this year, 1952, that smokeless zone came into being—but in the date of its becoming effective it had been beaten by 14 months by Coventry, who obtained their powers two years later than Manchester, but, as their area was mainly a blitzed site, had fewer difficulties to overcome in making their plans effective. The actual comparative figures were: In Coventry, where most of the land is city owned, there were 30 acres of ruins and rubble, with only 179 premises remaining standing and only 144 open grates in use; whereas Manchester zone area had 2,128 grates in use when re-surveyed in 1949, and only 12 of these burnt smokeless fuel. Bolton, and a number of other authorities have taken similar powers to Manchester and Coventry, but have not yet implemented them. Salford's application to do so has been recently refused by the Minister after public enquiry, the supposed reason being a present shortage of suitable fuel. As Salford proposed to deal with a very largely slum area this is very disappointing. One of the Coventry officials, in a private communication to me makes the following interesting comment on infringements:

> "Where these have been observed it has been found that they were due to ignorance or negligence on the part of employees. To give two examples, first, a member of a local firm of solicitors whose offices overlook the Council offices telephoned the Town Clerk's department and complained that a chimney in the offices was emitting dense, black smoke. Investigation showed that this was due to workmen burning, on the sectional boilers used for space heating, old linoleum removed from office floors. In a second case smoke was observed issuing from an incinerator in a yard at the rear block of temporary shops; these shops are owned by the Corporation and the contractor who erected them kindly

supplied an incinerator for the joint use of the occupiers. The estates department of the Corporation were asked to have the incinerator removed."

He says further that all opposition seems finally to have died away, and it has not been necessary to institute any prosecutions.

Sulphur

The other topical subject I wish to refer to is Sulphur. The enormous amount of damage done to surrounding vegetation due to the emission of sulphur dioxide is well-known. So is the great need of sulphur in this country today. Calculating sulphur as being now worth £25 per ton here, the Fuel Research Station estimate that the quantity of sulphur emitted from the combustion of coal is about 2½ million tons per annum, resulting in 5 million tons of sulphur dioxide. We therefore arrive at the huge figure of £62,500,000 per annum lost in the air every year, plus the incalculable value of the lost and damaged vegetation and property, and also plus the value of the lost and damaged health, as the annual waste loss value of sulphur. Facilities exist at certain large London power stations to require the removal of sulphur dioxide from the flue gases, but have not been fully exercised since the war. Even when they were, the sulphur was not recovered in a useful form. Here surely is a problem worth serious research, a problem of vital importance to the Nation at the present time.

The Third Des Voeux Memorial Lecture

SMOKE AND THE LAW

by

W. R. Hornby Steer, M.A., LL.B., F.R.San.I., Barrister-at-Law

Standing Counsel to the Society.

This is the third Des Voeux Memorial Lecture, and I naturally regard it as a great honour to have been chosen to undertake this responsible task and to deliver this important lecture at a conference attended by so many possessing wide practical experience of atmospheric pollution.

I am particularly glad to be associated with this lecture, which, as its name makes clear, is a memorial to the work of Dr. Des Voeux. I first met him when I was a small boy, and he was the medical adviser and trusted friend of a near relative of mine. Those of you who knew Dr. Des Voeux will not be surprised that I was greatly impressed by his remarkable personality. For over forty years he made coal smoke abatement his chief interest. In the words of Sir Lawrence Chubb: "He never allowed himself to be daunted by difficulties that might well have discouraged a lesser man." Dr. Des Voeux was the first President of this Society, and for many years carried out the duties of that office with great distinction. There can be no doubt that he deserves an honoured place in the ranks of those who have striven for a cleaner atmosphere.

I understand that it is not desired that this lecture should be a factual statement of the law relating to smoke, but that on the contrary, it is desired that the lecture should be on broader and more general lines. I shall therefore venture to put before you a number of matters related to the control of smoke nuisances which I hope may be of some interest to those who are normally engaged on the more practical aspects of this subject.

So far as I am aware, the first actual record of the use of coal in England is a receipt given by the Abbey of Peterborough in the year 852 for "twelve cartloads of coal." It appears that its use spread, and that before the close of the reign of Edward I it was being dug to some extent in most of the coalfields of England, Wales and Scotland.

An early instance of smoke nuisance occurred as long ago as 1257, when Eleanor, Queen of King Henry III was obliged to leave the town of Nottingham where she had been staying during the King's absence in Wales and removed herself to Tutbury Castle owing to the smoke of the sea coal. Coal was then known as sea coal by reason of the fact that the coal first mined in England was dug from the sea shore where the carboniferous strata was exposed by the washing of the waves and tides and was called sea coal in order to distinguish it from charcoal.

Smoke abatement, to use the modern term, appears to have begun in London in 1273 when sea coal was prohibited from being used as being prejudicial to human health, and even the smiths were obliged to burn wood; and it may perhaps be claimed that the earliest association of men for the purposes of smoke abatement and thus the forerunner of the National Smoke Abatement Society was when in 1306 the nobles, prelates and others going to London to attend Parliament were greatly annoyed by the increasing smoke and took the lead in getting up demonstrations against the obnoxious fuel in which they were joined by a great body of the populace. In consequence a Royal Proclamation was issued prohibiting artificers from using

sea coal in their furnaces. Little notice was taken, however, of this proclamation, and complaints still continued so that it was decided to have recourse to stronger measures to put an end to the use of coal. In 1307 a Commission of Oyer and Terminer was appointed with instructions—

> "to inquire of all such who burnt sea coal in the city, or parts adjoining, and to punish them for the first offence with great fines and ransoms, and upon the second offence to demolish their furnaces."

It is recorded that one man who disobeyed the King's command was tried, condemned to death, and executed for burning sea coal in London.

In the records of this Society there is a reference to an Assize of Nuisance in 1377, when Thomas Young, and Alice his wife complained that a neighbouring armourer had built a forge the smoke of which it was alleged entered their hall and chambers so that the value of their tenement was diminished to the extent of ten marks per annum. The result of the proceedings does not appear to be recorded.

In 1661 was published John Evelyn's tract "Fumifugium: or the Inconvenience of the Aer and Smoake of London Dissipated," in which he described the City of London as resembling ". . . the face rather of mount Aetna, the Court of Vulcan, Stromboli, or the Suburbs of Hell, than an assembly of Rational Creatures, and the Imperial seat of our incomparable monarch," and complained that "It is this horrid Smoake which obscures our Churches, and makes our Palaces look old, which fouls our Clothes, and corrupts the waters, so as the very Rain, and refreshing Dews which fall in the several Seasons, precipitate this impure vapour, which, with its black and tenacious quality, spots and contaminates whatever is exposed to it."

John Evelyn advocated legislation compelling the works of trades which were manifestly nuisances to the City of London such as "Brewers, Dyers, Sope and Salt boilers, Lime Burners and the like" to be removed five or six miles down the river.

A Bill was prepared during the reign of Charles I with the object of mitigating nuisances arising from smoke. However, the bill was not proceeded with and somewhat remarkably no steps of importance were taken in this connection for many years.

The Festival Exhibition held on the South Bank site last year has directed attention to the early history of that neighbourhood; and the following references to smoke nuisance arising there in early times may be of interest. The records of the Court Leet of the Manor of The Clink, Southwark, show that on the 14th October, 1690, Charles Bowles of Southwark, glassman, was fined or, to use the old word, amerced, the sum of fifty shillings for "perpetually disturbing the inhabitants of the Manor aforesaid and all persons by the smoke from his glass house in Rochester Yard within the said Manor." Rochester Yard was on Bankside, West of Southwark Cathedral. The above-mentioned Court Records also show that on the same date John Bowles and Phineas Bowles and partner were fined fifty shillings for a like offence.

Another interesting instance of complaint of smoke nuisance in that area is that of William Curtis, who, in 1779, opened the London Botanical Garden on a site now partly occupied by Waterloo Junction.

The reasons for his removal of his plants to a new site in Brompton are best given in his own words: "I had long observed with . . . regret, that I had an enemy to contend with in Lambeth Marsh, which neither time, nor ingenuity, nor industry, could vanquish; and that was the smoke of London, which, except when the wind blew from the South, constantly enveloped my plants."

The following instance is of interest as an early example of the efforts of an expert to belittle the injurious effects of smoke nuisance.

In 1839, Mr. John Fowler, to the annoyance of his neighbours, converted the factory between his house in Belvedere Road and the river into a white lead works. Mr. James Goding was the proprietor of the neighbouring and then newly erected Lion Brewery which until recently was a prominent feature on the South Bank Waterfront. Mr. Goding complained to his landlord the Archbishop of Canterbury, in consequence of which the Archbishop served on Mr. Fowler a notice in the following terms:

> To Mr. John Fowler:
>
> It having been represented to me William Lord Archbishop of Canterbury by James Goding Esq., to whom I have granted a lease of certain ground in the Belvedere Road—now in his occupation and used by him for a

brewery on a large scale—that a factory or building is in course of erection in the yard situate in Belvedere Road which you hold by lease dated 1 Sept., 1821 under me for the purpose as is alleged of manufacturing or preparing white lead and it having been further represented to me by the said James Goding that the working of such white lead factory will be a serious annoyance to the said James Goding with respect to his said brewery, I do therefore hereby give you notice to desist from the erection of the said factory—20 July 1839—W. Cantuar.

However, Mr. Fowler obtained a report from one Andrew Ure, M.D., Professor of Chemistry, dated 10 July 1839; he may perhaps be regarded as a predecessor of the learned gentlemen whom we are accustomed to hear giving evidence as expert witnesses in the Courts today. Professor Ure's report was in the following terms:

"This extensive factory is erected for making white lead according to the specification of a patent granted about 2 years ago to Messrs. Batton & Dyer. . . . Mr. de la Rue Jn., a partner and conductor of the said patent factory has evinced equal judgment and ingenuity in the structure . . . to prevent waste of product, injury to the health of the workmen and nuisance to the neighbourhood. The first stage of the process is the manufacture of litharge from metallic lead, for which purpose the chimney 60 ft. high close to the river site has been erected in connection with a furnace about 30 ft. distant, the iron flue of the furnace being conducted through a series of small brick chambers where the white lead is dried.

The next step is the agitation of the litharge along with a solution of nitrate of lead in an oblong copper pan. This can occasion *no possible annoyance*, *nor* can the decantation of the resulting subnitrate liquor into a series of settling cells. Being thus freed from the floating particles of litharge, the liquor is allowed to flow into a large round copper pan. . . . There are two ovens for making coke, which, being well constructed can prove *no ground of complaint* especially as coke ovens previously existed in the same premises.

The chimney furthest from the river is also 60 ft. high. It is intended for the furnace of the steam engine boiler and is quite unobjectionable."

It appears that in consequence of this partisan report, Mr. Fowler was permitted to establish the white lead factory. The factory buildings included two chimneys 60 feet high and two coke ovens. Fowler's original factory and ironworks is shown in the well-known aquatint of the Lion Brewery executed by George Hunt and F. C. Turner in 1836.

In 1819, a committee was appointed by Parliament with the duty to inquire how far persons using steam engines and furnaces could erect them in a manner less prejudicial to public health and comfort. In due course the Committee submitted a report which declared that the evidence bore out the practicability of smoke prevention but as has often happened to reports prepared by such committees before and since, no action was taken to implement the recommendations.

In 1843, a Select Committee recommended the introduction of a bill dealing with nuisances from furnaces and steam engines and expressed a hope that black smoke might eventually be entirely prevented.

In 1845 another select committee reported that in the then state of knowledge and experience it was not desirable to extend the provisions of any bill beyond the scope of furnaces used in the generation of steam. The work of these Committees was not without some success for a clause was included in the Railway Clauses Consolidation Act, 1845, requiring locomotive steam engines to be so constructed as to consume their own smoke and a clause was also inserted in the Town Improvement Clauses Act, passed two years later, in 1847, requiring furnaces used in factories to be constructed to consume the smoke arising from the fuel used.

A few years later, in 1853 and 1856, Acts were passed limited in their operation to the Metropolitan area empowering the police to enforce provisions against smoke from furnaces used in steam raising, other furnaces employed in factories, public baths and washhouses and furnaces used in the working of steam vessels on the river Thames.

An important step forward was the passing of the Sanitary Act of 1866, which empowered sanitary authorities throughout England and Wales to take action with regard to certain smoke nuisances. Those provisions were repealed by the great Public Health Act of 1875.

Among the provisions contained in the last-named statute were those which enacted that any fire place or furnace in trade premises which did not so far as practicable consume its own smoke and that any chimney (other than in a private dwelling house) sending out black smoke in such quantities as to be a nuisance should be deemed to be a nuisance liable to be dealt with summarily. Local authorities were required to cause inspection of their districts to be made from time to time with a view to abating nuisances and to enforcing the relevant statutory provisions. If a local authority made default in this respect the Local Government Board (as it then was) could authorize a police officer to take proceedings, the costs being recoverable from the defaulting authority.

The Act provided for service of notice requiring abatement of the nuisance, and, on non-compliance, complaint could be made before a Justice of the Peace who could make an order for the abatement of the nuisance and the carrying out of any necessary works and the imposition of penalties. Local authorities were empowered to enter premises for the purpose of enforcing the statutory provisions relating to smoke nuisances. Further, any person aggrieved by a smoke nuisance was entitled to lay a complaint before a Justice of the Peace with the same consequences as if the complaint had been made by a local authority. The Public Health (Amendment) Act, 1907 enabled those local authorities who had adopted it to make byelaws respecting the structures of chimney shafts for the furnaces of steam engines, breweries, distilleries or manufactories. The next important statutory advance was the passing of the Public Health (Smoke Abatement) Act, 1926. This Act was in large measure the result of the efforts over a number of years of voluntary bodies whose identity is now merged in the National Smoke Abatement Society, efforts with which Dr. des Voeux was so closely associated. The effect of the Act was that it was no longer necessary to prove that smoke was " black " in cases where smoke was emitted in such quantities as to be a nuisance. The definition of smoke was extended so as to include soot, ash, grit and gritty particles. The amounts of the penalties were increased. Local Authorities were empowered to make byelaws regulating the emission of smoke and were enabled to combine with other local authorities in undertaking investigations and researches into problems relating to atmospheric pollution and the abatement of smoke nuisances. The Act also made provision for securing the abatement of smoke nuisances on premises occupied by Government Departments.

In 1930 the Minister of Health appointed the Local Government and Public Consolidation Committee which, as its name implies, was appointed to consider the consolidation of the law relating to Public Health and the second interim report of that Committee is the basis of the Public Health Act, 1936.

This Act, so far as it relates to smoke is in consequence mainly a consolidation of existing enactments. It does not apply to the Administrative County of London which area is subject to control under the Public Health (London) Act, 1936.

Some important local authorities in areas where the problems of smoke abatement have been especially urgent, have obtained powers under Acts limited to their respective localities. Early examples are the Nottingham Improvement Act, 1874, the Leeds Corporation (Consolidation) Act, 1905, and the Bradford Corporation Acts, 1903-1913. Since the last war new principles for the prevention of smoke have been gaining favour, such as the idea of smokeless zones and prior approval of new fuel burning plant. Early examples of local acts giving statutory effect to these ideas are the City of London (Various Powers) Act, 1946, the Manchester Corporation Act of the same year and the Coventry Corporation Act, 1948.

Scotland is, of course, not affected by the Acts to which reference has here been made. The position in Scotland is governed by various Acts passed during the last hundred years—some of general application (the most important being the Public Health (Scotland) Act of 1897), and some local Acts for particular areas as, for example, that of Glasgow, and more recently the Edinburgh Corporation Order Confirmation Act, 1950.

Since 1946 there have been placed on the Statute Book more than twenty-five local Acts, all giving effect to the principle of prior approval, and in many cases making provision for smokeless zones. Particulars of these may be found in the current Year Book of the Society.

It must be remembered that statute law is not the only law administered by the Courts in this country, but that on the

contrary the basis of English Law are the principles of the Common Law, principles which have been developed through the centuries.

Smoke at Common Law, and apart from any statutory provisions may constitute an actionable nuisance. This may be so even when the smoke is unaccompanied by noise or noxious vapours and whether or not it is injurious to health. The test as to whether smoke is a nuisance at common law may be summarized in the question put by Lord Romilly, M.R., in Crump v. Lambert (1867) L.R.3. Eq. 409, when he asked: "does the annoyance produced materially interfere with the ordinary comfort of human existence? In the well-known case of *Walter v. Selfe* (1851) 64 E.R. 849, Knight Bruce, V.C. applied the test "ought this inconvenience to be considered as more than fanciful, more than one of mere delicacy or fastidiousness as an inconvenience materially interfering with the ordinary comfort physically of human existence not merely according to elegant or dainty modes and habits of living, but according to plain and sober and simple notions among English people?"

The advantages of taking action under Common Law rather than under the statutory procedure are threefold:

(1) Loss sustained can be compensated by damages awarded against the Defendant;

(2) The future may be safeguarded by undertakings "given by the Defendant and included in an enforceable as part of the Order of the Court; and

(3) If, as is invariably the case, the Order of the Court includes "liberty to apply," it will not be necessary to commence fresh proceedings in the event of the nuisance recurring.

An action for nuisance at common law is the appropriate remedy against smoke emitted from the chimney of a private house which is, of course, excluded from the statutory nuisances defined in section 101 of the Public Health Act, 1936. I will not dwell on the legal position today, which is probably a matter with which most of those present are very familiar, and is in any case a matter upon which information is easily accessible. It is, however, to be noted that generally speaking the law—both Common Law and Statute Law—has been based on the principle that smoke, like other nuisances such as loud noises or offensive smells, was not prohibited absolutely but only checked or abated when it was of such a degree as to constitute a nuisance. As is well known, a number of difficulties have arisen in practice affecting the administration of the Public Health Acts by local authorities.

Difficulties which will be present in the minds of those actively engaged with such problems include the following:

(1) the defence under Section 103(3) that the best practical means have been taken to prevent the nuisance;

(2) the exclusion of smoke from the chimneys of private houses from the operation of section 101; and

(3) the failure to secure the enactment of byelaws as effective as the circumstances require, in particular for the control of smoke of colour other than black, and for the provision of smokeless heating and cooking equipment in new buildings.

It must, I think, be assumed that the present form of smoke control under the Public Health Acts will continue for a number of years and that the immediate objective of those concerned with smoke abatement should be to make the existing form of control as effective as possible. This objective will be promoted by the methods promulgated by this Society not least by securing a greater number of smoke inspectors and by improving the conditions and status of those possessing the necessary qualifications.

I suggest that whereas in the past the steps taken to secure smoke abatement have been based on prosecution and penalties the tendency in the future will emphasize the necessity of preventing the nuisance from arising by controlling the conditions which give rise to smoke . . . in short, the keynote of future action to abate smoke nuisances will be "Prevention rather than Prosecution."

One example of this trend will, I hope, be the gradual increase and expansion of smokeless zones, an idea first suggested by the late Mr. Gandy, Chairman of the National Smoke Abatement Society. In my view this is an aspect of the greatest importance. It has been the subject of interesting and valuable papers and articles with which the members of this conference are no doubt acquainted. The first smokeless zone came into operation in Coventry on March 1st, 1951, and was followed by Manchester on May 1st of

this year. As already stated, a number of other local authorities have obtained statutory powers for this purpose.

It is a matter of regret and disappointment that the Minister of Housing and Local Government has declined to sanction the proposals submitted by Salford Corporation.

Smokeless zones in the limited number of cases for which powers have been obtained are, of course, for the time being experimental, but there can be no doubt that their possibilities are considerable.

Another direction in which the tendency of prevention rather than prosecution is apparent is the development of the method of prior approval. This is also a matter in which the Society has rightly given assistance and encouragement. The application of this principle is probably as important for purposes of fuel economy as for smoke prevention. This method of control is happily developing and I understand that a factual progress report thereon is being given at this conference and will no doubt be of great interest. The practical aspects of developing control of this character by legislation may require a review of the administrative aspects of smoke prevention. If control is to remain in the hands of the present local authorities, there will be a need for a larger number of officers qualified in combustion technology. This naturally gives rise to the question as to whether or not control could be more efficiently and economically carried out by authorities exercising powers over larger areas such as Joint Boards or possibly regional authorities who would have the assistance of expert technical advice not available at present to some smaller authorities.

I suggest that the urgency of the need for more effective control of the sources of smoke nuisance is such that we cannot afford to wait until such time as the ordinary Local Government boundaries may be revised to suit the needs of modern requirements but that consideration of the boundaries of areas for purposes of smoke control is a matter which brooks no delay.

The valuable comments relating to this matter contained in Mr. Marsh's well-known book *Smoke* deserve the fullest consideration of all concerned; The rapid increase in the number of dwellings now being erected by housing authorities draws attention to the great contribution that could be made to the reduction of smoke nuisance by restricting the heating facilities therein to electricity, gas or smokeless fuels; this naturally leads to the consideration of the conditions that can properly be imposed in granting licences for the erection of dwellings by private individuals. Experience of cities in which advance has been made in smoke abatement shows that the best results need more than the existence of Acts of Parliament and Byelaws, they require the active co-operation of owners and business executives who are in a position to determine, or to have determined, the cause of smoke from their plants.

Many industries, factories and buildings have old boilers or furnaces which are inefficient or too small for present requirements. Replacement of or changes in such equipment may be expensive but will often prove a good investment by reason of consequential reductions in costs. In these days the complication of modern civilization tends to a greater consideration of action calculated to safeguard the welfare of individuals. It is wrong that countless individual citizens should suffer damage to their health, property or comfort by preventable nuisances caused by the selfish few.

The degree of smoke regulation or air pollution control will, in large measure depend on the temper of public opinion in the area. In the long run it is the force of public opinion that determines the nature and degree of control which will be tolerated by a free people and it is of importance that public opinion should be directed in the right way. It is for this reason among others that conferences such as this can play an important part in the achievement of our aims.

It is of interest to note some of the steps taken to deal with the problem of smoke in countries abroad.

Whereas in this country penalties sometimes severe have been imposed for the causing of smoke nuisances, in the United States of America the approach to the problem was different. When smoke abatement measures were begun they inflicted no penalties, but inaugurated an educational programme which involved many meetings and classes for different groups.

Organized smoke abatement in the United States may be said to have started in 1866 in the City of St. Louis, Missouri. Since that time more than 200 cities in the United States have undertaken smoke abatement and air pollution control programmes in greater or less degree. You may think that the term " Smoke Regu-

lation Engineer" which is there applied to the municipal officer concerned with these matters is an appellation which has much to be said for it. The more recent ordinances all provide for regulation by strict prior approval accompanied by fees for the necessary certificate which assist the finances of the smoke control authority.

In Canada the City of Montreal has recently been much concerned with these problems. Montreal now has an entirely new smoke and air pollution byelaw, and a new Smoke Control Division administered by qualified engineers and inspectors.

The byelaw provides for a penalty of 40 dollars per day for violation of the prescribed standards and limitations in smoke emission, and requires that plans must be submitted to the Smoke Control Division for approval before permits are given for any future installations or alterations and that present installations be rectified to conform with the prescribed requirements. This Smoke Byelaw was prepared after a careful study of a great number of byelaws in force in different cities and has been found to be most effective.

In June of this year it was estimated by the municipal authorities of Montreal that there was only a quarter as much railway smoke there then as a year ago, and only half as much factory smoke. This improvement cost $1,250,000. Seven inspectors and two engineers with appropriate office staff were employed throughout the year.

In Australia the problems of atmospheric pollution have recently been attracting attention in the city of Newcastle, New South Wales, a city which claims to be the industrial capital of the Commonwealth. This City has enjoyed rapid and prosperous development of Industry, and is today faced with the problem of how to effectively minimize atmospheric pollution so as not to interfere with productivity.

The first practical step has been the establishment of a Smoke Abatement Advisory Panel which created leadership in this field in Australia.

The Panel comprises members of the Health Committee of the City Council and representatives from the local Institute of Engineers, Maritime Services Board, Railway Department, Chamber of Commerce, Chamber of Manufacturers and a fuel and technical expert all operating in a voluntary capacity and meeting at monthly intervals.

It is stated that the efforts of the panel have resulted in many improvements and that the drift towards greater pollution synonymous with industrial expansion has been arrested.

In most, if not all of the countries of Western Europe laws for the protection of public health may be applied against the nuisance of industrial smoke.

In general the penalties are mild and complaints are often made as to the ineffectiveness of the operation of the legal provisions by reason of them not being observed. However, where legal action has been taken the general experience is that invariably a marked improvement occurs.

Those of us at the Conference are well aware that much remains to be done in this country in order to achieve our aims and that the successes gained by our efforts in the past are in no sense grounds for complacency in the future. Nevertheless, I believe it to be true that in this vital matter of smoke abatement this country is giving leadership to all those who are our allies in this crusade in countries abroad and overseas.

PROGRESS REPORTS

AIR POLLUTION AND CANCER OF THE LUNG

by

Percy Stocks, C.M.G., M.D.

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In evidence relating to probable effects of the location of industry on death rates in the past, given by the General Register Office to the Royal Commission on the Geographical Distribution of the Industrial Population some fifteen years ago, I mentioned the higher mortality from respiratory diseases which had always characterized towns on the western side of the Pennine Chain compared with those on the Yorkshire side. Mills and factories had usually been built in the bottoms of the valleys, convenient for rail, road and canal transport, and the dwelling houses had tended to spread up the hill slopes, with the result, I suggested, that since the prevailing winds were westerly, the east Lancashire towns were generally more pickled in their own smoke than the Yorkshire towns. This applied also to parts of the Potteries; but as an example of an industrial city which seemed to me to escape the worst of its smoke and rather to inflict it on the countryside to the east, dimming the sun over long distances, I instanced Sheffield whose death rates from respiratory disease were low.

At that time, when we thought of fatal respiratory disease, it was in terms of pneumonia, bronchitis and tuberculosis of the lungs, which together were causing about 80,000 deaths a year in England and Wales in 1935. The death rates from those causes had for long been falling slowly, but another disease was coming into the picture, without attracting much attention, namely cancer of the lung and bronchus, which doctors recognized as the cause of about 3,400 deaths in 1935. During the next 15 years the position changed very greatly, for thanks partly to the discovery of the sulphonamide drugs and penicillin, the total deaths from pneumonia, bronchitis and pulmonary tuberculosis fell to about 60,000, whereas those attributed to lung cancer increased to 12,000. When drawing conclusions from such startling changes it has to be remembered that many deaths from lung cancer were not recognized as such in the past, being attributed to pneumonia or chronic bronchitis, or occasionally to phthisis. Infection often caused lung cancer patients to die of pneumonia in an early stage of the disease before its true nature could be recognized, whereas now such early death may be prevented by the new drugs, and the cancer then progresses and is diagnosed as such by the time it proves fatal. However that may be, it would be dangerous to assume that the steady and rapid increase in lung cancer mortality, as indicated by death certificates, can be explained away so conveniently, for the year by year increase shows no sign of lessening. We have to anticipate now that out of any assembly of 400 men aged about 55, at least ten will die of lung cancer within the next 20 years, even if the rate remains at its present level.

Carcinogenic Substances

Although we do not yet know the true nature of cancer, quite a number of chemical substances have been proved to be carcinogenic, that is to say capable of producing cancer when continually or frequently in contact with certain parts of the body. People exposed to such substances repeatedly in the course of their occupations often developed cancer,

and by suitable precautionary measures chimney sweeps, mulespinners in cotton mills and chrome workers have for long been protected from skin cancer. Similarly, handlers of certain luminous paints need to be protected against cancer of the bones, and chemical workers in certain processes of dye manufacture against cancer of the bladder. It was reasonable to suppose, therefore, that lung cancer could be induced by inhalation of some carcinogenic substance, which might come from coal gas, road dust, petrol fumes, smoke from domestic chimneys, industrial smoke, tobacco smoke, or some other source of air pollution. It has been found, for example, that lung cancer is very prevalent amongst certain workers in the chromate industry, and in a particular mine where the dust was very radio-active; and statistics also indicate some excess of mortality in some occupations connected with coal gas production. With these facts and possibilities in mind, the Medical Research Council called a conference in 1946 to consider what investigations could be carried out, and a working party initiated several studies which have already proved fruitful.

In the first place, a series of 709 patients found to have lung cancer in a number of London hospitals were questioned as to their history of tobacco smoking, and compared with a series of patients found to have cancer in other organs such as the stomach, or no cancer at all. The results, published in a paper by Doll and Bradford Hill in 1950,[1] showed a remarkable preponderance of heavy tobacco smokers amongst the lung cancer patients. Cigarette smokers were more liable to develop the disease than pipe smokers, and the risk appeared to increase in proportion with the number of cigarettes smoked. Only two men who had always been non-smokers were found amongst 649 cases, compared with 27 amongst the same number of men in the control group who did not have lung cancer. Inhaling did not appear to add to the risk. A similar study by Wynder and Graham in America,[2] of 605 men with lung cancer, produced almost the same result, except that the risk seemed to be increased by the habit of inhaling. These researches have proved, in my opinion, that tobacco smoking is an important factor in the genesis of lung cancer; but they have not proved that it is the only important factor, and statistical evidence can now be advanced in favour of the view that atmospheric pollution by some carcinogenic substance present in smoke from domestic chimneys may be an additional factor.

In a report on the Regional Distribution of Cancer Death-rates in England and Wales, issued from the General Register Office in 1947, I showed that London and certain large cities, notably Manchester, Liverpool and Nottingham, had peculiarly high rates for lung cancer during the decade 1921-30; and that there was in general a steep downward gradient of rates from London, through large and small towns to rural districts. Furthermore, amongst the county boroughs there was a curious correspondence in the reverse sense between their lung cancer death rates and annual averages of the amounts of recorded sunshine. I concluded that either smokiness of the atmosphere is an important factor in itself in producing cancer of the lungs, or sunshine is an important factor in preventing its incidence.

Atmospheric dust is known to contain at least three substances believed to be carcinogenic, namely arsenic, benzpyrene and radio-active particles. Of these arsenic is also present in tobacco; and it has been found recently that the arsenic content of urban air is twice as great in winter as in summer, suggesting that domestic consumption of coal is the chief source since industrial smoke does not vary greatly with season.[3] However, it has been estimated that the amount of arsenic inhaled in a year by ordinary breathing would only be of the order of half a milligram, or the content of about 100 cigarettes. Waller[4] has just shown that the benzpyrene content of the air of eight towns had an even more pronounced winter excess than arsenic, and that it increased with size of town, these facts making it probable that domestic smoke is the principal source of the benzpyrene in the air.

Death Rates in Towns

Such findings seem to link up with the results of a further statistical research on death rates in English towns which I completed a few months ago and which has been published in the *British Journal of Cancer*.[5] First of all I worked out standardized mortality figures for cancer of the lung and bronchus amongst males in each County Borough and each Metropolitan Borough during the recent period 1946-49. The County Boroughs and London were then arranged in groups according to the number of inhabited dwellings at the last census, and when two or more of the towns were actually

contiguous (as for example Liverpool, Bootle, Birkenhead and Wallasey) they were treated as a single unit. There were five groups of adjacent towns having more than 200,000 occupied dwellings, and of these the London, Manchester and Merseyside groups gave lung cancer indices around 160, whilst the Birmingham and Leeds groups registered 134 and 132. It is interesting to note that in the first three groups the population densities per acre were 25 or more, whereas in the Birmingham group it was 20 and in the Leeds group only 11. A high population density per acre implies also a high density of domestic chimneys per acre, and, assuming the proportion using coal fires to be constant, pollution of the atmosphere by domestic smoke must depend on at least three factors, the total number of dwellings, their concentration together and the effects of wind. I will refer to wind presently; what I wish to point out here is that, apart from the size of town, there is a positive correlation between density per acre and lung cancer mortality.

Let us now look at the other towns, in descending order of the number of occupied dwellings. Sheffield comes next with 124 thousand dwellings, and its mortality figure was 135, similar to Birmingham and Leeds. Then come Newcastle with Gateshead, with 87 thousand dwellings and a mortality figure 114; and a group of 6 towns each having between 50 thousand and 85 thousand dwellings, giving an aggregate mortality figure 113. After that come 3 towns each with 40 thousand to 50 thousand dwellings, mortality 107; 12 towns each with 30 thousand to 40 thousand dwellings, mortality 104; 13 towns, each with 20 thousand to 30 thousand dwellings, mortality 100. Finally there are 29 towns having less than 20 thousand dwellings, which gave an aggregate mortality figure of 89. The lung cancer mortality index for men decreased with remarkable regularity, therefore, according to number of occupied dwellings, from about 160 in the largest and most crowded urban groups to 89 in the smallest. Within the groups having less than 50 thousand dwellings there was a large variation for individual towns, which could be explained by the small numbers of deaths in any one town and by special peculiarities. The seaside resorts Brighton, Southend, Eastbourne and Southport have rather high rates, but they are dormitory towns and places to which many men retire after working a lifetime in London, Manchester and Liverpool, so they seem to be exceptions which prove the rule. Cardiff and Swansea also have higher rates than their sizes seem to warrant, as have also St. Helens and Warrington.

I have repeated this analysis for deaths of females using a long period of 19 years from 1921 to 1939 in order to get large enough numbers, because the ratio of male to female mortality at ages between 45 and 65 is about 7 to 1 in the towns and $4\frac{1}{2}$ to 1 in rural districts. The result is much the same, except that no sign of any increase with size of town occurs until 40,000 dwellings are reached, the mortality index I used remaining around 75 in towns up to that size. The index then rises quickly to levels of 120 to 140 in urban areas with over 100 thousand dwellings.

The Population Density

When the population densities of large cities are examined in detail, it is found that the density per acre in successive zones around the business centre falls off according to a mathematical law as the distance from the centre increases. If domestic smoke is an important factor in producing a disease, then if there was no wind at all the highest incidence of that disease would be expected about the centre of the town, diminishing in all directions outwards. If there was wind coming from every direction equally over the year, a more diffused, but still symmetrical, distribution of incidence of the disease would be expected. Actually wind does not blow from all quarters equally, and I find that when the wind directions at Greenwich in 12-hour periods throughout the year 1950 are analysed, wind was blowing from one quarter of the circle distributed around WSW during half the time, whereas it was coming from the reverse quarter around ENE, and from each of the other quarters, during only one-sixth of the time. The expected effect of this prevailing direction on smoke density would be to shift the maximum some distance from the centre of Greater London towards ENE. It is interesting to find, therefore, that the map of lung cancer mortality in the county of London during 1946-49 shows a large black patch with the highest death rates covering Finsbury, Shoreditch, Bethnal Green, Stepney and Bermondsey, just where it should be. This might be due to peculiarities of social distribution rather than to smoke and movements of the atmosphere, but there is no evidence as yet that lung cancer is more prevalent

in one social class than another, taking the country as a whole.

It is safe to say, I think, that the statistical facts we have extracted so far fit in rather well with the hypothesis that atmospheric pollution by domestic smoke is an important factor in the genesis of lung cancer, and that tobacco smoking is superimposed upon it as another important factor. One cancer producing substance might be common to both kinds of smoke in which case the risk of contracting lung cancer would depend on the total dose received from both sources; and from that it would follow that it is more dangerous to smoke 30 cigarettes a day if one lives or works in a large town than if one lives and works in the country. The same would be true if the carcinogens A and B are different but nevertheless are additive in their effects in the sense that whilst the body could safely deal with, say, one milligram of either A or B, its defences might not stand against both together. If A and B act independently, however, the relation between risk of lung cancer and number of cigarettes smoked should be the same for town dwellers as for country dwellers. An investigation has now been started by the British Empire Cancer Campaign in Liverpool Hospital Region and North Wales in the course of which we hope to find out whether that is the case or not, and also to see whether smoking habits are different in town and country and whether any other factors are associated with lung cancer, such as use of anthracite or oilstoves.

Much of what I have put before you is no more than conjectural as yet, but it can be and will be tested by field research. If it proves to be a correct interpretation, then it will provide an additional incentive to the work of your Society. It will do more than that, however, because if the aggravating causes in cancer of the lung can be identified and then abated to some extent, the same might be done for other forms of cancer which are responsible for much suffering. Ten per cent. of prevention would be much better than ten per cent. improvement in the results of treatment. Tuberculosis has been gradually defeated in the last 80 years, not by spectacular destruction of the tubercle bacillus by some wonder drug but by abating one by one those social factors which intensify the doses of infection we are exposed to, and those nutritional factors which lower the defences of the body against the bacillus. Cancer may have to be defeated in the same sort of way; and I think that in the long run the perseverance of your Society will contribute to that, as it has already undoubtedly contributed to the reduction of other diseases.

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REPORT FROM THE U.S.A.

by

Henry Burns

Senior Inspector, Air Pollution Control District, County of Los Angeles, California

It is with great pleasure that I find myself here again to renew old friendships and participate in your programme. I am grateful for the kind invitation asking me to add a bit concerning the work of our organization, and the progress we have made.

While I had not planned this purposely, what I have to report by way of progress seems to dovetail exactly with your current problems. In the past fiscal year, due to our system of Prior Approval, industry in Los Angeles County has installed *basic equipment* valued at £12,830,000. This brought the total installation cost of *basic equipment* since the inception of Prior Approval, to £18,100,000. During this four-year period, *control devices* installed by industry on basic equipment with the approval of our engineering department, cost £2,355,000 of which £873,000 was spent in the last year. The total cost of operating the Los Angeles County Air Pollution Control District for the 1951-1952 fiscal year was a mere £164,500.

As a result, a very marked reduction in air pollutants can definitely be shown. Prior Approval has been the main factor in the reduction of 300 tons of sulphur dioxide, 80 tons of smoke, and 60 tons of dusts, fumes, and mists. Let us not lose sight of the fact that these are *daily figures*. This reduction has brought about a total overall daily elimination of all air contaminants of approximately 30 per cent. These results could not have been accomplished without a rigidly enforced programme coupled with intense research in trying to determine the reasons for air pollution.

The obvious being now definitely known and controlled, our research programme has taken us a step further along the road of progress. The latest developments tend to show that invisible gases, high ozone content, and unsaturated hydrocarbons, are, among others, great contributors to the problem. Although only recently identified as a source, unsaturated hydrocarbons are already being eliminated to the tune of 80 tons daily at the refineries.

While it is still too early to be definitely positive, a series of experiments conducted by Dr. A. J. Haagen-Smit of the California Institute of Technology, have shown that gasoline vapours and oxides of nitrogen, under the action of sunlight, form peroxides, aldehydes and acids, as well as ozone. Combinations of these materials in the atmosphere tend to produce a chain reaction that keeps increasing the pollution. On the basis of these discoveries, steps are being taken to eliminate as many of the sources as possible so as to still further reduce the man-made poisons in our air.

Needless to say, the expenditures for approved basic equipment as well as for control or collection equipment is not always a total loss for industry. For example, in the collection of sulphur dioxide emissions from the refineries, certain chemical companies as well as the refineries themselves, are able to recover elemental sulphur and to produce sulphuric acid and ammonium sulphate. Thus not only are the contaminants removed from the atmosphere, but also in so doing, a valuable product is produced which is in rather short supply at the moment and which helps to pay in part or in toto for the cost of the control equipment.

In closing, if I am permitted the liberty, might I say to you, "continue the good work." If there are any present who have doubts as to the values of Prior Approval, these few facts presented which show a result of our work, should be a spur toward your goal, which is exactly like ours. Again let me extend my appreciation for being permitted to add my bit, and in your welcoming me "home as it were."

CONSULTATIVE ADVISORY COMMITTEES IN LANCASHIRE

by

Alderman Ethel Hanley, M.B.E., J.P.

Chairman—Health Committee, Borough of Widnes

Introduction

The Consultative Advisory Committees in the North West Division are as follows:

	Formed
Borough of Widnes ..	Feb., 1947
St. Helens and District ..	June, 1949
Burnley and District ..	Nov., 1949
Borough of Rochdale ..	Jan., 1952
Nelson and District ..	Feb., 1952

In each case, the initiative to establish the Committee came from the major local authority as can be understood, and while the constitution varies in detail, each Committee is representative of different local interests and points of view, and includes also regional representatives of the Ministry of Fuel and Power, Gas and Electricity Authorities, together with the Alkali Works Inspector for the area. It should be stated that the advice and assistance of these latter members have proved of great value.

The objects of the Committee are of course, the same in each case though perhaps differently expressed, but in essence they are:

(*a*) To create and maintain public

interest in the abatement and prevention of air pollution from whatever source;

(*b*) To deal with the difficulties of factory owners in regard to smoke and fumes emission, fuel problems, plant, equipment and the like;

(*c*) To consider new developments in technique in relation to smoke prevention;

(*d*) To educate boiler-house personnel in proper methods of stoking, etc.

(*e*) To act as liaison between the Local Authority and the factory owners.

The Committees are of course, consultative and advisory only, the statutory powers being exercised by the individual local authorities, who also meet such approved administrative expenses of the Committees as may be incurred.

Borough of Widnes

The first Committee to be established was at Widnes just over five years ago. Widnes is an industrial town in South-west Lancashire with a population of 48,000, the chief industries being heavy chemicals and copper refining.

There are 45 major factories with over a hundred chimneys emitting smoke and gases, from boilers, furnaces and other processes, and numerous low stacks and outlets which do not break the skyline but are capable of emitting smoke and fumes. For power plant alone there are 116 Lancashire and 19 other type boilers. Seventy plants are mechanically stoked and 61 are hand-fired. Added to this there are approximately 13,900 dwellings and business premises.

The factories are situated roughly in the form of an arc from south-east to south-west of the town. All winds between these two points convey the factory smoke over the centre of the town and the residential areas, whilst from the other direction the pollution is chiefly from domestic fires.

During the year 1935 steps were taken by the Local Authority to estimate the amount of the pollution. They therefore became a co-operating body with the D.S.I.R. and two deposit gauges were placed in selected positions. Recordings were taken until the outbreak of the war which gave the following average monthly deposits, in tons per sq. mile :

1936	43.76
1937	30.6
1938	34.26
1939	29.46

These figures proved that Widnes had a serious smoke problem, and in 1946 the Borough Council made a Byelaw under section 104(1) of the Public Health Act, 1936, but were unsuccessful in obtaining its confirmation by the then Minister of Health.

Adopting a different approach to the problem therefore, a local conference on Atmospheric Pollution was convened under the auspices of the Health Committee, which resulted in the formation of the Consultative Committee.

Meetings are held quarterly when the Senior Sanitary Inspector presents a report on the recordings of deposits, smoke observations and the difficulties and complaints which have been dealt with. During the last two years the Committee have visited various factories by arrangement with the managements to obtain first-hand knowledge of the processes and the precautions taken to minimise or prevent nuisance.

Deposit Gauges.—In September, 1947, three stations, each provided with a standard deposit gauge and lead peroxide apparatus for the estimation of sulphur dioxide were put into operation, and following upon a recommendation of the Consultative Committee a further two stations were installed in 1950. There is now a record of the extent of the pollution in Widnes, over a period of five years from which the following average monthly deposits in tons per sq. mile have been taken:

1948	22.45
1949	20.97
1950	20.58
1951	23.74

These figures show a large reduction from the pre-war recordings.

Estimation of Sulphur.—Sulphur dioxide from processes other than the combustion of fuel at times gives a high recording, but it is remarkable how favourably Widnes compares with other industrial towns, especially considering that heavy chemicals is the main industry. During 1951, sulphur as measured by the five widely-spaced lead peroxide instruments and expressed in milligrams of SO_3 per day, per 1,000 square centimetres, revealed the highest daily average to be 31.14 mgms. in January and the lowest 11.4 mgms. in July, the daily average throughout the year being 17.25 mgms. A smoke filter and volumetric sulphur dioxide apparatus has been provided which is mounted on a base board. Being portable, this apparatus has been used with success in various parts of the town in investigating com-

plaints of smoke emission during night time. It is in daily operation at the Health Department which is situated in the centre of the town.

Smoke Observations.—Daily observations are made, and in all cases of excessive emission, graphs of the observations are sent to the managements concerned.

Weather.—Daily recordings are made of the rainfall, maximum and minimum temperature, humidity and the wind direction and velocity.

An anemo-biagraph has recently been installed at the Health Department which provides accurate details of wind force and direction throughout the full day making it possible to trace sources of pollution and greatly assists in the investigation of complaints of smoke or fumes when specified times of emission are stated.

Domestic Smoke.—Every encouragement is given to householders to install fireplaces for the burning of smokeless fuels and the local builders have proved to be very co-operative on this point. The Local Authority in their new houses, and in all replacements of fireplaces, fit only grates which are capable of burning smokeless fuels.

Publicity.—During 1950 and 1951 three exhibitions were held in Widnes in connection with Local Industries and Local Government. At each, the Committee had a stand showing the steps being taken to reduce smoke. These efforts were well patronized and thousands of pamphlets were distributed. One pamphlet contained photographs of the town during heavy smoke emission and the opposite effect on a clear day with little or no smoke. This had a very large circulation and aroused great interest.

Education.—Soon after its formation, the Committee, appreciating that much factory smoke could be eliminated by efficient stoking, arranged several lectures with instructional films on boiler-house work at the Technical College.

A class of 15 attended the second session, but in the third year the class had to be abandoned for lack of numbers. As efficient stoking is of course most essential, the Committee still have the matter in hand including the difficult question of bonus payments for efficiency.

Whilst the emission of smoke has been the chief pre-occupation of the Committee, smells, fumes and dust have also received attention. New chemical processes, the effects of which have not always been foreseen, and sometimes breakdown of plant, have brought their usual crop of complaints, but patient investigation and co-operation by all concerned have generally resulted in all-round improvement, and the influence of the Committee in this connection has been most noteworthy.

As was pointed out at the inception of the Committee the policy then determined was a long-term one; immediate results were not expected but comparative statistics given in this report do show a considerable improvement, especially when it is borne in mind that not only has industrial development in the Borough expanded considerably since 1939, but the number of dwellinghouses has also increased by 30 per cent.

The St. Helens and District (Atmospheric) Pollution) Joint Consultative Committee

This Committee was established in June, 1949 and covers the County Borough of St. Helens, Whiston Rural District and Prescot Urban District. The Committee is constituted on similar lines to that at Widnes.

Deposit Gauges, etc.—The St. Helens Council, being a co-operating body with D.S.I.R., have installed four deposit gauges and six lead peroxide instruments, together with a smoke filter apparatus, for the estimation of pollution.

The recordings show the following average monthly deposits, in tons per sq. mile:

1950	..	20.79
1951	..	21.34

Tabulated results of smoke observations taken since the formation of the Committee are circulated to individual factory owners after being submitted to the Committee. Each chimney in the district has been given a code number and the managements are able to follow the reports of their own particular chimneys.

Sulphur dioxide.—The highest daily average of sulphur dioxide in 1950 was in February with the result of 35.9 mgms./1,000 sq. cm., whilst the lowest average was in June with 12.8 mgms. In 1951, February had again the highest daily average with 26.5 mgms. and July the lowest average with 10.3 mgms.

Weather.—A meteorological station, situate in Victoria Park, is maintained by the Public Health Committee. Daily readings and observations are taken by a member of the Sanitary Department.

Education.—Several film shows and lectures by experts have been given on

various aspects of atmospheric pollution.

On numerous occasions over a period of years attempts have been made to organize classes for boiler-house personnel in St. Helens.

Film demonstrations, letters to employers, personal and individual appeals to the personnel in the boiler-houses have all been carried out in order to attract entrants. An attempt to form classes has also been made by the Ministry of Fuel and Power without success. In all cases the numbers did not justify the formation of classes. The Ministry of Fuel, in their case, were only able to obtain the final promise of three persons and the matter had to be abandoned.

The formation of classes for boiler-house personnel has constantly been before the Consultative Committee and is still under discussion.

Co-operation with Industry.—The fullest co-operation has been obtained from the factory owners in respect of the work of the local Committee. This fact is emphasized by the number of improvements which have and are being carried out, and also the interest shown in the Committee by the members representing the different factories.

Burnley and District Smoke Abatement Advisory Committee

This Committee was formed in November, 1949 and has made good progress. Its work is on similar lines to that at Widnes and St. Helens. Quarterly meetings are held when reports on deposits are discussed together with difficulties experienced by manufacturers in regards to the prevention of smoke emission, fuel problems, etc.

The County Borough of Burnley has in force a Byelaw made in 1935 under the Smoke Abatement Act, 1926, limiting the emission of black smoke to two minutes out of thirty.

Deposit Gauges.—The Burnley Corporation have placed three deposit gauges at selected points in the Borough. The records give the average monthly deposit in tons per sq. mile as follows:

1950 ..	20.62
1951 ..	21.60

All smoke observations are reported to the managements concerned whatever their results.

Weather.—The climatological records are kept at the Public Health Department and supplied daily to the Borough Analyst.

Publicity.—From the large attendance at lectures and film shows, and the active part played by members of the Committee, it is evident that the object of making the citizens of Burnley and district smoke conscious is progressing satisfactorily.

Education.—Courses in advanced Boiler-house Practice have been carried on successfully for many years at the Burnley Technical College, and the Principal and Sectional Heads of the College have been instrumental in stimulating the interest of boiler firemen particularly by variation of the sessional courses held during the last three winters.

The Medical Officer of Health is of opinion that these courses have resulted in more efficient stoking and have encouraged boiler-house personnel to take greater interest in their job and the diminution of smoke. He states that there is probably a slight improvement on the emission of smoke from individual chimneys though this is not as yet indicated on the widely-spaced gauges.

Co-operation with Industry.—Factory owners have been definitely co-operative, and the representative of the Chamber of Commerce and the Chamber of Trade on the Advisory Committee have done much to secure and increase co-operation from factory executives.

Rochdale Joint Consultative Committee

Only one meeting has so far been held, when considerable information relating to smoke abatement generally was submitted. The progress of events in regard to the smokeless zone in Rochdale will be of special interest to this Committee.

Records.—The Rochdale Corporation maintain three deposit gauges. For the year 1951 the average monthly deposit was 18.368 tons per sq. mile.

No observations on particular factory chimneys are sent to the management concerned unless, of course, a nuisance is found to exist, when the statutory duty of immediate notification is carried out.

Three lead peroxide instruments have also been installed and a Meteorological station established at the Rochdale Hills Sewage Works under the supervision of the Borough Surveyor.

Education.—No classes have yet been formed for boiler-house personnel. Enquiries are being made to assess the amount of interest and the numbers likely to attend.

Visits to works to enable the Committee to see various types of boilers are contemplated and efforts to enlist the interest and support of the general public will be made by way of suitable films, exhibitions, etc.

Nelson and District Smoke Abatement Advisory Committee

This Committee was formed early this year and follows the pattern of the other four already dealt with.

At the moment Nelson Corporation have one deposit gauge and one lead peroxide gauge in operation. Recordings commenced on March 1st, 1952, the results so far being as follows: Deposit gauge, in tons per sq. mile—March, 10.74; April, 9.97. Lead peroxide gauge, in SO_3 mgms. per day per 1,000 sq. cm.—March, 20.2; April, 17.0. Two further stations are in contemplation.

Education.—As the Committee was only inaugurated in the early part of this year, it has not yet been possible to arrange classes for boiler-house personnel. During the coming Autumn, however, it is intended to hold a series of popular lectures, illustrated by suitable films, and it is hoped that Anthony Greenwood, Esq., Member of Parliament for Rossendale, who takes a keen interest in the economics of black smoke, will address the inaugural meeting.

Co-operation with Industry.—Local factory owners have been most co-operative and several firms are carrying out improvements to their plant, recommended to them by the Sanitary Inspector.

Immediately a smoke observation is made of a factory chimney, the District Inspector inspects the boiler plant and interviews the personnel. The following day a letter is forwarded to the firm concerned, containing details of the observations and suggestions towards effecting an improvement in the plant and a reduction in the amount of smoke emitted.

Byelaws.—The Nelson Council are facing the same difficulty in regard to Byelaws as Widnes. The Minister is of opinion that the adoption of Byelaws should be deferred in view of the present conditions regarding fuel. Unfortunately one or two persistent offenders do not display the co-operation desired and the Council regret the decision of the Minister to defer the confirmation of the Byelaws.

Conclusion

Five years is the longest period covered by any of the Committees referred to in this Report, a period which is far too short in which to say more than that the records of smoke emission show gratifying indications. The period has been one of preparation and planning, record taking, and getting down to the root causes of the problem in each area. We now know our " bad chimneys " and in most cases the reasons why they are so. The results so far may be summed up as follows:

1. The public of our areas are now fully aware of the evils of air pollution. It is a good sign that they are no longer willing to tolerate the heavy emissions of black smoke as formerly, and they are not slow in expressing resentment against such emissions as our Committees know only too well.
2. The industrialists are now alive to the fact that excessive smoke is wasteful and uneconomical, and smoke emission receives the same serious attention of managements as other factory problems. Moreover, there is now a distinct willingness on their part to join with Health officials in investigating complaints whether arising from smoke, smells, fumes or dust, and to discuss ways and means of overcoming them.
3. It is realized that efficient stoking is essential especially in the older type of plants. Notwithstanding difficulties arising from shift work and other causes (not the least being a prejudice by many stokers against " going to school again "), the experience of the Committee has proved that the proper training and personal co-operation of boiler-house personnel must be secured as many complaints are due as much to indifferent or careless stoking as to poor quality fuel.
4. That whilst Consultative and Advisory Committees do facilitate co-operation between the Health Authorities and the industrialists (and much good work has been and can be accomplished in this way), the Local Authorities feel that they would be in a much stronger position to deal with certain cases if the existing powers of constituent Authorities were augmented by Byelaws (confirmation of which is at present being withheld by the Ministry) made under section 104 of the Public Health Act, 1936.
5. It is recognized that the real object of all parties in this matter—the prevention of atmospheric pollution—is the same though its achievement may be desired for different reasons.

Acknowledgements.—Thanks are due to the Town Clerks of St. Helens, Burnley, Rochdale and Nelson and to the Medical Officers of Health and the Chief Sanitary Inspectors of these Boroughs for the information they have furnished and their co-operation.

PRIOR APPROVAL

by

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Prior approval has for its object the prevention of smoke. It has been achieved either by the promotion of informal advisory consultations, or alternatively local legislation has established some measure of control over new furnace installations.

Prior approval of new chimneys, boiler houses and fuel burning plant has been carried out in some of the larger cities of Great Britain for many years. The functioning of permissive prior approval as carried out in Birmingham, Sheffield and District, and in Leeds was reported upon at the Annual Conference of the Society held at Cheltenham in 1948. A section dealing with prior approval of furnaces is included in the Birmingham Corporation Act, 1948; but undoubtedly much of the success of prior approval in Birmingham was due to the arrangement whereby plans for new industrial and commercial building were passed to the Health Department for scrutiny. In Sheffield and Leeds prior approval was achieved solely by the administrative arrangement under which plans submitted to the local authority for approval under the building byelaws and for planning consent under the Town and Country Planning Act were passed by the City Building Surveyor to the Health Department for comment. In all these cities this procedure enabled smoke inspectors to approach the depositors of unsatisfactory plans and discuss details of the proposed fuel burning plant. In most cases manufacturers and architects have accepted suggestions designed to promote efficiency and smokelessness.

The Manchester Powers

Legal provisions for the prevention of smoke from industrial furnaces by prior approval were first embodied in the Manchester Corporation Act, 1946. These provisions, somewhat extended and slightly modified by the Manchester Corporation Act, 1950, are as follows:

1. "(1) No person shall instal in any building whether erected before or after the passing of this Act or on any premises any furnace unless such furnace is so far as practicable capable of being operated continuously without emitting smoke;

"(2) Any person who contravenes the provisions of this section shall be liable to a penalty not exceeding ten pounds and any person who after there has been a conviction of an offence of installing a furnace in contravention of those provisions uses that furnace shall unless it has been altered so as to comply with those provisions be liable to a penalty not exceeding two pounds for each day on which he so uses the furnace:

"Provided that a person so using such furnace shall not be liable to the last-mentioned penalty unless he himself was convicted of the said offence or if he was not so convicted unless prior to such use or the continuance of the use he had received notice from the Corporation that there had been a conviction in respect of the installation of such furnace.

"(3) If a person before installing in a building a furnace to which this section applies submits to the Corporation plans, proposals and particulars of the proposed furnace and furnishes them with such other necessary information in regard thereto as they may require the Corporation shall within a period of six weeks from the date upon which such plans, proposals, particulars and information are received by them serve a notice upon which person stating whether or not they are satisfied that the furnace is so far as practicable capable of being operated continuously without emitting smoke and if they are so satisfied or if they do not serve a notice upon such person before the expiration of the said period of six weeks no proceedings shall be taken against him under this section in respect of the

installation of that furnace in accordance with the plans, proposals, particulars and information so submitted and furnished.

"(4) In determining for the purposes of this section whether a furnace is so far as practicable capable of being operated continuously without emitting smoke the Corporation or a court shall if either of the parties so desire have regard to cost and to local conditions and circumstances."

2. "Nothing in this section or in the said section 36 shall apply to the installation of a furnace in—

(*a*) a house or flat unless the furnace is intended to be used for the heating of more than one house or flat; or

(*b*) a building previously used as a single house which has been converted into two or more separate houses or flats.

3. "For the purposes of this section the expression 'house' shall include a house of which part is licensed by the justices for the sale of intoxicating liquor pursuant to the Licensing Acts 1910 to 1949 notwithstanding that the premises are so licensed provided that the house is not designed and is not being adapted to provide more than three bedrooms for visitors or guests."

4. "Before the Corporation serve a notice under subsection (3) of the said section 36 as amended by this section stating that they are not satisfied that a furnace is so far as practicable capable of being operated continuously without emitting smoke the Corporation shall consult with the Minister of Fuel and Power."

A code of requirements for steam raising furnaces in Manchester was then formulated so as to facilitate the consideration of plans and proposals and to assist industrialists who sought advice on constructional features of proposed installations. It is to be noted that this scheme has made the submission of plans for prior approval a voluntary act; but has provided an incentive in the form of the removal of threat of proceedings. Fortunately the officials concerned with smoke abatement had knowledge of all existing installations, and of conditions likely to lead to the installation of new furnaces. In addition the City Architect forwarded to the Health Department all plans which indicated that furnaces were likely to be installed in new or altered buildings. Then the industrialist or consultant concerned was notified of the relevant sections of the Act and thus particulars of projected installations were discussed informally. It is reported that in general industrialists have shown a marked degree of co-operation in meeting the requirements of the Corporation.

Local Progress

In Edinburgh local powers in regard to prior approval were contained in the Edinburgh Corporation Order, 1950 and these were similar to those of Manchester. Administrative arrangements have been made whereby all plans submitted to the City Engineer for approval by the Dean of Guild Court have been regularly scrutinized to ensure that where alterations to boiler house plant and furnaces were contemplated the requirements of smokeless operation were brought to the notice of the firm concerned. Six installation schemes were approved in the year 1950 and seven in 1951.

In Bradford powers of prior approval have been in force since January, 1950, and two schemes have been submitted for approval. The proposals with regard to furnaces were satisfactory but modifications were required in both schemes in the proposed height of the chimney. The Bradford Improvements Act, 1850, empowered the Council to fix the height of chimneys in certain cases.

In Coventry prior approval was based on Section 52 of the Coventry Corporation Act, 1948, which enacted that "no person shall instal in any building in the City whether erected before or after the passing of the Act any furnace for steam raising or for any manufacturing or trade process unless such furnace is so far as practicable capable of being operated continuously without emitting smoke." In the case of a proposed new installation plans proposals and particulars may be submitted to the Corporation. When the proposed plant did not comply with the Corporation's code of requirements discussions were arranged. These have always resulted in the necessary adaptation to satisfy prior approval.

The Bolton Corporation Act, 1949 contained similar provisions for the voluntary submission of proposals relating to new furnaces. The Bolton Health Department has set up a panel to deal with the proposals as submitted. The panel consisted of The Medical Officer of Health, Chief Sanitary Inspec-

tor, a Fuel Technologist, The Regional Engineer of the Ministry of Fuel and Power, The Borough Engineer, and an Engineer nominated by Industry. This panel has first prepared a code of requirements for furnaces, and they have so far dealt with eight proposals.

The Salford scheme originated from the introduction of similar local legislation in 1948. The submission of plans is a voluntary act. During the past two-and-a-half years thirteen submissions have been received, only one has been rejected. In one case the proposals were approved subject to the proviso that the furnace be operated on coke.

In Paisley, power to make byelaws to achieve prior approval of fuel burning installations was obtained by Act of Parliament in 1947. Byelaws have not yet been drafted. Nevertheless prior approval has already operated in Paisley because all plans which have required Dean of Guild Court approval have been passed to the Chief Sanitary Inspector. Detailed information has then been obtained and after due discussion comments or recommendations have been submitted for the consideration of the Court. The Court has been concerned principally with structures and not with plant, but all new works or substantial alterations to existing works must thereafter receive the approval of the Town Planning Committee.

West Bromwich has had prior approval since 1949 and one application has been received for the re-siting of existing furnaces, but no applications have been made for the approval of the installation of new furnaces. However, a most useful administrative arrangement has developed whereby all plans relating to industrial development were forwarded to the Chief Sanitary Inspector for observations. This enabled the firms to be contacted and the proposed extension or new building sites to be visited to ascertain whether any new furnaces or processes were to be provided.

Smethwick acquired Prior Approval powers by a private Act of 1948, but as this County Borough is practically completely built up, new factories and furnaces are not being erected. One application for prior approval of boiler plant was received and the prior approval power enabled useful collaboration with the consulting engineer which led to approval being given by the Authority unconditionally.

Similar powers of prior approval by local act have been obtained by the following authorities, namely: Nottingham County Council, Brighton, Wolverhampton, St. Helens, Rochdale, Dudley, Leyton, Sutton, Slough, Swindon and Darwen and so far there have been no applications for prior approval.

Sunderland, Worcester, Crewe and Urmston have also had prior approval clauses inserted in local acts but these are not yet operative because the appointed day has not yet been fixed.

Criticism

Among the various criticisms that have been made against local acts which have provided for prior approval are:

1. Plans and proposals to be submitted to the local authority should not be limited to furnaces or even to installations for steam raising or for any manufacturing trade purposes but should extend to include all fuel burning installations.

2. To ensure that the initial advantages of prior approval are retained throughout the working life of an approved installation, it should be a condition of approval that the installation will be maintained in the form in which it is described in the plans and specifications referenced in the notice of approval, unless alterations become necessary to achieve greater heat output, such alterations being subject to sanction or approval by the Local Authority.

3. The submission of particulars of proposed new installations should be a compulsory requirement in every "Prior Approval Scheme."

4. The period of *six weeks* allowed for the local authority to indicate its decision is too short having regard to the delays entailed through *monthly* Committee and Council meetings.

In spite of these criticisms it is obvious that many local authorities have achieved satisfactory results with voluntary powers of prior approval. Other local authorities have accomplished prior approval without any specific power as such by relying on the Town and Country Planning Act, but without doubt the task would have been more readily accomplished with the aid of suitable prior approval clauses.

Prior approval has only succeeded and can only continue to bring good results where it is administered with a sympathetic regard for the efficient running of the plant.

Prior approval of fuel burning plant, however achieved, is a useful means of reducing smoke by focusing the attention of all concerned on the desirability of good appliance and plant design, before the installation of the plant.

REVIEW OF THE FUEL RESEARCH STATION'S INVESTIGATIONS OF ATMOSPHERIC POLLUTION

by

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1. **Foreword.** It was in 1927 that the Department of Scientific and Industrial Research first undertook the investigation of atmospheric pollution which is now centred at the Fuel Research Station. Since that time the importance of the subject in so many aspects of community life has become more widely recognized and this trend has been paralleled by an increase in the amount and emphasis of the Department's work on the subject. From time to time various features of this work have been described in the Proceedings of this Society and elsewhere, but it seemed appropriate in this 25th year of the Department's participation to give a general review of the scope of the investigations now being undertaken. It is also appropriate that this review should be presented to the National Smoke Abatement Society, with whose work the programmes described in this paper have been so obviously complementary.

Broadly the Station's present activities include investigations on the abatement, measurement and, to a lesser extent, the effects of atmospheric pollution. This work is undertaken by several teams, one of which is largely concerned with general aspects of pollution over the country as a whole and includes co-operation with Local Authorities and other bodies having special interests in atmospheric pollution. A second team is investigating and developing a process for the recovery of sulphur compounds from flue gases, particularly those emitted by electricity generating stations. Other teams are concerned with the combustion problems of industrial boilers and domestic heating and cooking appliances.

2. **Co-operation with Local Authorities, etc.** Under the present arrangements the Department is responsible for maintaining the organization of the Standing Conference of Co-operating Bodies on Atmospheric Pollution which includes representatives of local authorities and other bodies making regular observations of atmospheric pollution by approved methods in various parts of the country. The Standing Conference is an autonomous body which normally meets twice a year under its own chairman for discussions and to receive a report of the Atmospheric Research Committee of the Fuel Research Board.

The number of Co-operating bodies taking part in this scheme has steadily increased to a present total of 140 and it is particularly gratifying to be able to report a 100 per cent. increase in representation in the last three years.

The numbers of instruments in regular use for making observations of various kinds now totals about 1,208, of which 110 are maintained by the Department in connection with its various programmes and 1,098 by other Co-operating bodies. The numbers and types of instruments which comprise the latter total are as follows:

Deposit gauges	453
Sulphur dioxide instruments	557
Smoke filters	88

The value of data obtained in this way for assessing existing levels of pollution and for use in preserving and improving local amenities needs no emphasis. Additionally, such data obtained from a sufficient number of widely scattered test points provides a valuable means of studying some nation-wide aspects of atmospheric pollution.

The Department's aim is to give the fullest co-operation to the bodies undertaking this work and, in addition to making available suitable apparatus, the Fuel Research Station regularly gives advice on the selection of test-sites, the operation of the apparatus and the interpretation of the results. Each month the

results from all co-operating bodies are collated at the Fuel Research Station and circulated in the Atmospheric Pollution Bulletin together with a summary of current technical literature. Copies of the Bulletin are provided to all co-operating bodies.

3. **F.R.S. Sulphur dioxide Surveys.** The increasing number of large electricity generating stations now coming into use raises questions concerning their effects on atmospheric pollution in nearby and more distant localities. As a contribution to the study of these problems the Fuel Research Station is undertaking a survey of the pollution by sulphur dioxide in one rural district and in four areas in London in which large power stations are situated.

These surveys will have to be continued for a considerable time before the pattern of pollution under various conditions becomes apparent, but it is hoped eventually to obtain a composite picture of the pollution over larger areas.

4. **Test Methods.** The main pollutants with which present programmes are concerned are depositable matter, sulphurous gases and smoke. The deposit gauge is now well established and has recently been made the subject of a British Standards Specification. Sulphur is estimated by two methods which give useful results but are being further investigated in order to improve their reliability. Smoke is estimated by a filtration method, often operated in conjunction with a sulphur dioxide estimation, in which the density of the resulting stain is measured by comparison with a standard either visually or photo-electrically.

As atmospheric pollution research progresses new test methods are required and two apparatuses are being developed at the Fuel Research Station for special purposes. One of these employs an electrical conductivity method of estimating sulphur dioxide which has the advantage of high sensitivity and thus opens up the possibility of making and recording readings at frequent intervals. By this means it is hoped to correlate changes in pollution with meteorological and other factors. The other apparatus which is now in the prototype stage is a simple daylight recorder in which the output from a photo-cell is suitably amplified and made to operate a counting device which thus gives an integrated reading covering any desired period. It is hoped that this apparatus will prove a useful tool in the study of daylight absorption by smoke haze, etc.

5. **Abatement of Industrial Smoke.** Details of the Fuel Research Station's earlier work on this subject have been previously published (1) and it is only necessary to say at this time that the F.R.S. Smoke Eliminator Fire-door, designed for improving the performance of hand-fired natural-draught boilers, is coming increasingly into use by industry. These fittings are being manufactured by several commercial firms and some hundreds of them are now in use and are giving good results on various types of hand-fired boilers in many parts of the country.

In some more recent experiments attempts have been made to find whether a further improvement in performance resulted from increasing the turbulence in the combustion chamber. In these trials, which were made on the Lancashire boiler at the Fuel Research Station, air was forced by means of steam jets into each furnace through nozzles situated over the fire-doors. These nozzles were dimensioned to allow the same amounts of air to enter as with the Smoke Eliminator Door but at velocities up to fifteen times that hitherto employed. A number of devices have been tested including guide vanes or helices in the nozzles to give a rotary motion to the entering air and tests have been made using various sizes of coal and with different loads on the boiler. From the results obtained it appeared that no striking improvement resulted from the use of the higher inlet air velocities under the test conditions but data were obtained which should assist in the designing of smoke eliminators suitable for use in forced draught installations.

6. **Domestic Smoke.** The Fuel Research Station is responsible for making the official tests of commercially produced domestic heating appliances. Only when these tests have shown that an appliance meets the agreed standards of performance can its name be included in the list of "Recommended Domestic Solid Fuel Appliances" issued by the Coal Utilization Council in consultation with the Ministry of Fuel and Power. The Station also has under investigation other programmes concerned with the more fundamental aspects of domestic heating.

Many modern designs of domestic heating appliances operate with considerably higher thermal efficiency than

those of some years ago. If this increased efficiency results in a reduction in the amount of coal consumed some abatement of atmospheric pollution is to be expected. However, it is by no means certain that any significant reduction in fuel consumption will accompany the adoption of the more efficient appliances because many users will prefer to burn the same amount of fuel as formerly and thus to enjoy a greater degree of warmth.

Tests show that the proportion of smoke produced by these modern appliances is not appreciably less than that from the older types and so no ready solution of the domestic smoke nuisance is yet in sight. Some reduction in smoke emission is to be expected if and when circumstances permit the recommendations of the Simon Report to be put into effect. With this possibility in mind current studies of appliances include tests of their operation with smokeless fuels.

Papers dealing with the work of the Fuel Research Station on the composition and measurement of smoke were presented at the Edinburgh Conference in 1947 (2) (3). These experiments are being continued, including the study of an improved method of measuring the optical density, and hence the approximate concentration of solid matter, in chimney effluents. The new system is a photo-cell arrangement which possesses the feature that it is self-compensating with respect to variations in the electrical supply to the projector lamp and amplifier.

7. **Recovery of Sulphur from Flue-gases.** The only processes hitherto used for extracting oxides of sulphur from flue-gases on a large scale involve scrubbing with water containing natural hardness or added lime. These processes are relatively costly when applied to a modern electricity generating station because of the enormous volume of gases to be treated and because the resulting product, calcium sulphate, is in a form which is of no commercial value.

A process which would have the advantage of producing saleable products is one in which the gases are scrubbed with ammonia liquor. A process on these lines was originally proposed and tested by Messrs. Simon Carves Ltd. and the Metropolitan Borough of Fulham, but the method then used for controlling the scrubber was not entirely satisfactory. Subsequently an electrical method was developed for measuring and recording the concentrations of sulphur dioxide and ammonia in equilibrium with the absorbing solution under working conditions and a small unit was erected at the Fuel Research Station to test this method of control (4). The results obtained with this first apparatus were sufficiently encouraging to justify the construction of a larger plant which is now undergoing test.

This plant, designed to pass 25,000 cu. ft. of flue-gas per hour, consists of a scrubber 14 ft. high and 1 ft. 6 in. diameter packed with wooden grids. In this scrubber the gases are treated with a solution of ammonia and ammonium salts, the concentrations of which are maintained by withdrawing solution as necessary and adding water. Concentrated gas liquor is added at a rate corresponding to that at which the oxides of sulphur are absorbed.

The effectiveness of the scrubber has been studied in relation to the amount of grid packing which it contains and it has been found that in the experimental plant an increase in the depth of the packing from 2 ft. 6 in. to 5 ft. increased the efficiency of sulphur extraction from 88 to 92 per cent. With the 5 ft. depth of packing the loss of ammonia with the exit gases amounted to between 4 and 10 per cent. of the input. In these tests it was also found that some of the scrubber liquor tended to be carried away by the exit gases and it has been necessary to develop an effective spray trap.

The liquor withdrawn from the scrubber, consisitng of a 40 per cent. solution of ammonium sulphate, sulphite, bisulphite and thiosulphate, is subsequently processed by filtering, adding a small amount of sulphuric acid and heating in an autoclave to a temperature of 180° C. at a pressure of about 200 lb. per sq. in. With this treatment the mixed salts are converted into a mixture of ammonium sulphate and elemental sulphur in the ratio of about 10 : 1 on a weight basis.

The economics of the process will obviously depend largely on the price paid for the ammonia used, but it seems likely that if the outstanding technical problems can be solved the net cost of operation should be considerably lower than that of either of the existing processes.

8. **Miscellaneous Assistance.** The Department has provided assistance to various firms, research organizations, etc. on matters relating to various aspects of atmospheric pollution. The following are some recent examples of these

activities:

(1) Financial assistance to Sheffield University in connection with the investigation by Prof. Sarjant on the reduction of smoke emission from metallurgical furnaces.

(2) Co-operation with the British Iron and Steel Research Association in studies of the corrosive effects of atmospheric pollutants.

(3) Co-operation with the Ministry of Agriculture and Fisheries in connection with an experimental farm in an area selected because it is exposed to considerable atmospheric pollution.

(4) Visits to several works, together with the local sanitary inspectors, to advise on the avoidance of nuisances due to smoke, burning rubber and other industrial procedures.

(5) Assistance in obtaining samples for medical research.

The Department has recently arranged for the production of a cinematograph film dealing with the more efficient use of coal in industrial boilers, including means of reducing the emission of smoke therefrom.

9. **Acknowledgment.** The work described in this paper forms part of the programme of the Fuel Research Board of the Department of Scientific and Industrial Research and is published by permission of the Director of Fuel Research.

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SMOKELESS ZONES AND OTHER METHODS IN THE PREVENTION OF DOMESTIC SMOKE

by

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Why has there not been more attention paid to domestic smoke? It is our major problem today in air pollution. It has been so for a long time. Nearly 300 years ago, John Evelyn deplored with " Just Indignation " the " Clouds of Smoake and Sulphur, so full of Stink and Darkness." We cannot blame the industrial revolution for that! Much as we may complain about individual industrial chimneys, our chief difficulty is with domestic smoke. Industrial chimneys, taking the country as a whole, are proving less troublesome as time goes on. Domestic smoke as Dr. Parker and other experts agree causes at least half of our total pollution and an even higher proportion of the worst pollutants such as sulphur and various tarry products which do significant damage to health.

As I look out of a high office window in an industrial area I can count twelve factory chimneys—not all of them smoking. But I also might see 20,000 domestic chimneys; many of them smoking. The same scene is commonplace in industrial areas. How high and obvious is the smoking factory chimney, whilst the real but not apparent problem of the thousands of domestic chimneys continues with barely a protest or any attempt at remedial action.

Also one must admit that industry, admittedly mainly for its own ends, often lessens our problems by modernization of plant and in other ways. We find, too,

a far more public-spirited attitude nowadays on the part of the managers of large undertakings both private and public. More plans of new furnaces are being submitted for "prior approval" whether there be an official and/or compulsory scheme in force or not. More and more our smoke abatement officers are becoming welcomed advisers and educators to the staffs of all grades in industry rather than inspectors and "prosecutors."

But what action are we taking to attack the main enemy of domestic smoke? Firstly let us unit solidly and strongly behind the Society's policy on smokeless zones. It is a progressive and positive policy; it is so adaptable and flexible to meet the varying needs of different areas. Many of our previous policies have failed to lessen smoke pollution; the loopholes and difficulties of application of the policy for example of reducing the limits of permissible pollution have rendered the efforts of local authorities almost valueless as a means of realizing a decisive improvement. Yet there has been a vast advance in scientific and technical knowledge in recent years.

The public must be converted more completely; for there is a lack of enthusiasm in one or two high places; where, however, there might be also sensitivity to any strong demand by the electorate.

If we can provide in the homes of the people more smokeless grates and smokeless fuel burning in them, we shall provide more "demonstration centres" where neighbours and visitors will be able to see for themselves how clean, convenient, cheap and cheerful is the result. At present some members of the public are too inclined to "pass the buck," to "let other people become smokeless first" and to blame other areas and industries for smoke infiltration.

Let us demand more experimental areas where the smokeless zone principle may be demonstrated in varying conditions and circumstances, where details of the advantages and difficulties can be revealed. From the experience gained, a decision may be taken as to the wisdom of expanding the zones and in what areas new zones may be established.

Authorities with smokeless zones powers are empowered to contribute to the costs involved. There is a natural tendency not to use these powers because of possible abuse, but there is no reason to suppose that all applications for assistance would not be judged on merit. Coventry has dealt with a few such cases and thought fit to refuse assistance in each of them; I understand Manchester has decided similarly. Salford had certainly not made a definite decision regarding policy. Circumstance may arise where financial assistance could not be reasonably withheld, albeit there is no impediment to the use of bituminous coal except that it be burned smokelessly. It may be an arguable point whether such a possibility is within the realms of practicability. It should be noted, however, that in both the new zones there are plants operating on bituminous coal to the satisfaction of the local authorities and therefore apparently without smoke. The burning of bituminous coal is rightly discouraged.

Let us now review the progress that has been made. I will leave it to the representatives of the areas I mention to give the conference a fuller report than the brief summary which follows.

Manchester has converted 104 acres of its commercial centre to a smokeless zone. It consists of 1,297 commercial premises, 118 light industrial undertakings, but contains only 68 dwelling houses. Among other most beneficient purposes, the zone will form a useful research project, from which other towns will be able to learn much.

Coventry's smokeless zone has been in being since early 1951, but its size (30 acres) does not permit so much in the way of research. There the opportunity was taken to redevelop the "blitzed" commercial centre on smokeless lines.

Rochdale is prepared to go forward with its 67¼ acre smokeless zone proposal if there is a reasonable chance of the scheme being approved. The present intention is that the Order shall become operative in late 1953 or early 1954 and the zone will be similar to Manchester's in composition. Bolton has not quite reached that stage, but it cannot be the desire of either authority to waste valuable time on some very remote possibility.

Some reference to the rejection of *Salford's* scheme may be mentioned. Was it too ambitious, too large a scheme? The question has since been put. There were three zones of 750, 320 and 160 acres, all principally residential and containing some 5,000 houses, a third of which are municipally-owned.

The Minister was entitled to apply modifications, but such a course was not

taken. Steel shortage was not considered so important as fuel scarcity.

Few objections had been lodged against the Order. Property owners and owner/occupier organizations provided the fiercest opposition based on the cost involved in converting old appliances. It was significant that most objectors agreed with the need for a less smoky atmosphere, and even agreed with the method of achieving it, but invariably satisfying themselves that it should be inaugurated elsewhere and, of course, pointing to smoke infiltration from other areas as a reason. The person who had survived to a ripe old age in spite of the smoke was produced to prove something or other. On the other hand many letters were received from individuals conveying their good wishes and meetings called for the express purpose of registering disapproval of the project were not as one-sided as might have been expected. It is hoped to make a new proposal very soon.

As a result of it all we now know that there exists a keener interest in smoke pollution and its abatement than was ever imagined. Apathy is being conquered, but how sad to have to acknowledge that it is only other people's smoke the majority are interested in! Enforced smokelessness could stir up a violent objection to smoke pollution thereby forcing the pace considerably.

Educational Efforts

What can be done to bring about a general realization of the needlessness of smoke? Smokeless zones can do much by demonstrating the fact on a large enough scale.

Women's organizations, local trades councils, youth discussion groups and the like could open more of their meetings to speakers. It is for the members of the Society to produce them. There would be no dearth of applications for them once the service was known. The subject could form a science or physics lesson in schools. The Women's Advisory Council on Solid Fuel is doing something in this respect, though the object there may not be primarily "smoke abatement."

Industrial smoke, whether it is or is not less plentiful or harmful could be attacked with greater vigour, even with the unsatisfactory weapons now available. There must be a wider adoption of "Prior Approval." It is difficult for people to understand why they should be called upon to become smokeless whilst a local factory is permitted to spoil the effect most of the time.

A modern solid fuel appliance can be a good financial investment within the reach of everybody. The North-Western Gas Board makes purchase an attractive proposition by its hire-purchase arrangements. The cash price of the simpler types, with gas jet is £6 5s., including fixing, connections and taps. Hire-purchase terms are an initial payment of 7s. 3d., with quarterly payments of the same amount for five years, a total of £7 5s. Where a house is without a gas supply the Board will provide it up to 30 feet from the main free of charge, beyond which the cost falls on the individual. Most dwelling houses are within 30 feet of a gas main. Where no mains exists along a road, one will be laid if the demand warrants it. In a smokeless zone there would be a reasonable demand. Even so, cases will undoubtedly occur where the cost of additional piping, etc., is high, but here again the Gas Board will always come to the rescue with reasonable instalment payment terms. An alternative where continuous burning fires are maintained and the cost of gas installation is not commensurate with the return is Calor gas. Equipment charges are quite reasonable and a good service is provided. Gas is the real solution to the ignition problem.

The alternative fuels, gas and electricity, are much more expensive in use than solid fuel. In general, it will be found that gas will be used for cooking and as electricity is cheaper and easier to instal it will be particularly useful for space heating in small offices, shops and house bedrooms or other places where auxiliary or occasional heating is required. The predominant space heating medium in the two existing zones is central heating for large blocks of offices, banks, cinemas and similar large buildings, coke being by far the most popular fuel. Some are fortunate enough to have an anthracite allocation, and an odd oil-fired boiler is met with. Smaller buildings either take heat from a central heating plant in adjoining buildings or rely on electrical appliances. Cooking in cafes and restaurants is principally by gas, occasionally by electricity, but rarely by solid fuel. Nearly all the open grates which previously existed in public houses are still used, probably only for topping-up heat but more than likely with an eye to the psychological effect, whilst they

have almost disappeared in shops and have been halved in offices. No real difficulty has been experienced in obtaining solid smokeless fuel supplies and materials for conversions and alterations were forthcoming without trouble.

The modern trend is towards gas for cooking, with electricity a poor second, to reserve solid fuel for space heating and use electricity for occasional heating of rooms. Coal shortages and rationing have intensified the changing over, so that in this respect the establishment of smokeless zones fits in with the accepted scheme of things. It cannot be imagined that smokeless fuel and appliance manufacturers will ignore the increased demands indirectly encouraged through the medium of smokeless zone application. Coke and low temperature carbonized fuel production has increased yearly since 1947. Even during the severe fuel crises of winter 1950-51, when coke stocks reached their lowest ever, the North-Western Gas Board was able to meet all its commitments. Would that coke was considered more as a by-product of gas production by the price-fixers! The general public cannot understand why the solid residue of gas-making is as expensive as the coal from which it is derived.

There then are some suggestions for attacking the smoke evil at its main source. All concerned in this great problem will have to show more fighting spirit in order to achieve the cleaner atmosphere we all desire and which would bring much benefit to the people.

Discussion

Dr. A. J. Shinnie (Westminster) in opening the discussion referred in particular to Dr. Percy Stocks' paper and said how fortunate the meeting was in having Dr. Stocks to address them. He is one of the most eminent of medical statisticians in the whole country and in line with his distinguished predecessors of the past, Farr, Tatham, and Stevenson, in the Department of the Registrar-General. It gave him particular satisfaction that a very distinguished member of the medical profession was in the presidential chair. One who had reached high eminence in medicine, municipal service and public health, for the learned Professor was qualified in public health and in his younger days had held a post as a Medical Officer in that service. Reference had been made to Dr. Des Voeux, their distinguished President for many years. He (Dr. Shinnie) had known Dr. Des Voeux for many years; more than 35 years ago he was one who had been in flourishing practice in Westminster and had served as a City Councillor for many years where he tried with considerable success to uphold the cause so dear to his heart.

To return to Dr. Stocks' paper he ought to remind the Conference that while Dr. Stocks had shown beyond all doubt that there was an increased death rate from lung cancer in the areas subjected to much industrial smoke, that did not necessarily prove that industrial smoke was the only cause but could not be dismissed as a contributory factor. He referred to Dr. Peter Kerley, the eminent radiologist, who had made a special survey in Ireland and found a rarity of cancer of the lung in Southern Ireland which Dr. Kerley attributed to its predominantly agricultural nature. Dr. Shinnie also deplored that a number of local authorities appeared to be extremely apathetic in regard to the menace of atmospheric pollution and he regretted that quite a number of Medical Officers of Health showed very little interest in this matter, particularly in the County of London. He hoped that the interest achieved by papers such as Dr. Percy Stocks' would stimulate health authorities throughout the country to the obvious ill effects on health caused by atmospheric pollution and would encourage such authorities to support the Society in their single-handed efforts towards this end.

G. W. Farquharson (Birmingham) said that whilst statistics, although revealing, often covered the most vital points of the subject under review, he felt that Dr. Stocks' report had indicated not only the value of cancer research but the need for the continuation of such research in regard to the dangerous substances as found in atmospheric dust, i.e., arsenic, benzpyrene, and radio-active particles. Assuming that statistical evidence was such that the carcinogenic substances present in domestic smoke might be an additional influence in the genesis of lung cancer as Dr. Stocks stated, it would appear that the most important factor in

atmospheric pollution recording should be the recording of these carcinogenic substances.

Within the area of the West Midland Division of the Society a certain amount of field work between a local authority and a professor at St. Bartholomew's Hospital had been in progress concerning medical research for carcinogenic substances in smoke polluted atmospheres. This had been carried out by means of an analysis of the dust on smoke filter papers used in connection with sulphur dioxide estimation. [Examples of summer and winter time smoke filter papers were shown.] According to Dr. Stocks, the winter records indicated that the arsenic content in the filtered dust was doubled during the winter, and the benzpyrene trebled.

The Conference had already heard from Dr. Wilkins of the D.S.I.R., that many local authorities were co-operating in the recording of atmospheric pollution. Results were interpreted by figures indicating soluble and insoluble deposits per square mile per month, and also sulphur dioxide records, either by the volumetric method, or the lead peroxide method.

Some local authorities had been co-operating with the D.S.I.R. for over twenty years. Figures had been published and discussed in many places, but to the general public they meant nothing. Beyond the raising of an eyebrow, and a saying of "Isn't it surprising," the subject fell flat and was forgotten.

Mr. Farquharson suggested to the Conference, that, to awaken public interest, greater stress should be emphasized on the possibility of a relationship between the carcinogenic substances found in smoke polluted atmospheres, and the rapid increase in lung cancer mortality.

This could be done. It was obvious that propaganda based on actual recorded results would be the most useful means, and he would ask Dr. Stocks, and also Dr. Wilkins, their opinion on the need for such records, even at the expense of the existing deposit gauge recordings which were carried out. He would suggest a larger filtering medium than the one now used, i.e., the smoke filter paper. The recording should be done on a monthly basis situated in areas predominantly domestic in character. With the goodwill of the Medical Research Council and the utilization of the Society's influence, and the D.S.I.R. co-ordinating the work of the local authorities and bodies already engaged in pollution recording, and directing the course of the filtering medium to the centres for the necessary specialized analysis of the arsenic, benzpyrene and radio-active substances, some data could be obtained.

He realized a lot of detail would have to be considered on such a procedure, but suggested a five year plan to cover such records. At the end of the period, if the figures could not be utilized or co-ordinated in any way with lung cancer research, then the scheme should be scrapped.

The cost of such a survey would, again, be a considerable factor, especially for the analyst's services, but he was of the opinion that if sufficient interest and enthusiasm could be aroused in this matter of air pollution and its influence on cancer of the lung, the Society and all concerned would get the financial support of the local authorities and the Ministries concerned, and would awaken public opinion towards their ideals.

James Law (Sheffield) speaking on Prior Approval stated that three years ago at Harrogate he adversely criticised certain local authorities with regard to Prior Approval and stated that the report should have been called a Report on Frustration and today he was returning to the attack quite unrepentant because the picture had not improved.

Manchester was the first city to seek powers for Prior Approval in 1946 and they were such a success that they were compelled to go back and have them modified and extended in 1950. He wondered how long they would function before they again sought further amendments?

Edinburgh obtained a Corporation Order in 1950 and the sum total of approvals made since then had been thirteen. Bolton obtained powers in 1949 and had so far dealt with eight proposals. Paisley obtained powers in 1948, but had not yet drafted any byelaws. The same story went on: Nottingham, Brighton, Wolverhampton, St. Helens, Rochdale, Dudley, Leyton, Sutton, Slough, Swindon and Darwen had powers which apparently were not in use.

Smoke prevention could only be carried out by co-operation and the will of the people. Acts of Parliament and local byelaws were quite useless for that purpose and he thought that Mr. Goodfellow's report on that subject emphasized the fact. At the end of his

report he stated " Other local authorities have accomplished Prior Approval without any specific power as such by relying on the Town and Country Planning Act but, without doubt, the task would have been more readily accomplished with the aid of suitable Prior Approval clauses." He wondered if Mr. Goodfellow was really serious about that statement?

He stated that they in Sheffield commenced a modest system of Prior Approval in March 1946, working under the Town and Country Planning Act, but relying on the goodwill and co-operation of the architects and developers to assist in the work.

Since that time over 3,500 plans of new and altered fuel burning appliances had been scrutinized and up to date only 12 appeals had been made to the Local Planning Committee asking for modification of the conditions. In every case suitable modifications had been agreed upon. Mr. Law asked why had that work been carried out with so little difficulty. He quoted Mr. Goodfellow at the end of his report.

" Prior Approval has only succeeded and can only continue to bring good results where it is administered with a sympathetic regard for the efficient running of the plant."

That was one aspect of its success, the other one was that that method was more " elastic " than the rigid " Prior Approval " asked for in the Local Acts of Parliament.

In Sheffield, they could not ask for a smokeless zone for there were too many factories working in the city centre, but they were making progress in re-development, building up an area that would compare, they hoped, with any other city centre when the scheme was complete. It would probably take longer than other smokeless zones, but it would be carried out by goodwill, and not compulsion. In other words, they were moving in harmony with the population, and the population was already moving forward in company with them.

His criticism of Prior Approval as submitted in Mr. Goodfellow's report was that many local authorities had tried to move forward more quickly than public opinion was prepared to go, and had failed dismally in the attempt.

In 1944 a band of enthusiasts drafted a scheme of Prior Approval which was afterwards printed and submitted to Conference in 1946. After discussion it was unanimously resolved to submit the draft to the Ministry of Health. What had happened to it and why had this draft never been submitted? It was also noted with regret that Mr. Hornby Steer in his oration did not even make mention of it.

Every month the Fuel Research Board issue a Bulletin giving details of pollution deposits all over Great Britain. When he looked at the astronomical rise in the pollution figures of some of the industrial towns, he became very pessimistic and used a slogan which might be of service to quite a number of people. He would like Conference to remember it particularly. It was this: " Smoke's a Joke—Let's Play."

Dr. J. Greenwood Wilson (Cardiff) said that he agreed with Dr. J. L. Burn that the persuasive and educational approach in smoke abatement was usually more successful than to take legal proceedings.

With regard to Dr. Stocks' paper, he referred to his own experiences in visiting many cities in the U.S.A., which had given him the impression that they had much less smoke pollution in their cities there than over here. He asked whether there was therefore, in accordance with Dr. Stocks' contentions, a correspondingly lower death rate from cancer of the lung than in this country.

R. Williams (Coventry), after paying tribute to the capable way in which speakers had introduced their papers, went on to draw attention to the publication of the Ridley Report published at the same time as the Conference was opened. He commented on the fact that the report recommended a compromise between the open fire and the stove which would enable the lovers of open fires to satisfy both their conscience and their comfort by adapting their existing open grates to the new type of continuous burning grate with restricted chimney throating.

Mr. Williams felt that this recommendation would go far towards achieving the objects of the Society in respect of domestic dwellings if the principle were widely adopted.

He pointed out that some of the medical speakers had, perhaps inadvertently, given the impression that sanitary inspectors relied too much upon their legislative powers and not enough on the educational approach. In actual practice, Mr. Williams felt that it was recognized by everyone, including the speakers, that the sanitary inspector would, of course, first try persuasive measures before resorting to legal expedients.

In many spheres of public health work similar views were being expressed as to the need for the sanitary inspector to be an educationalist. The dangers of such an approach when used to the exclusion of one's legal responsibilities were pointed out by Mr. Williams. By all means, he said, maintain the educational channel, so long as it is remembered that first and foremost under the existing legislation the sanitary inspector is still an enforcement officer. Indeed, according to Mr. Williams, some industrialists claimed that coal was being wasted today by too much draught being used in furnaces by firms who were anxious to avoid any legal proceedings, with the result that while no smoke was being emitted the thermal value of the coal was not being fully utilized. Mr. Williams did not wish to elaborate on this point, but thought it suffice to say that whether this claim was true or not there must come a time when public health and economics clash and on these occasions public health must be the paramount factor so far as the sanitary inspector is concerned.

G. H. Wilkinson (Corby U.D.C.) referred to the current *Smokeless Air* which contained a reference to the latest annual report of the Bureau of Smoke Control, Allegheny County, U.S.A. He had received a copy of this report and considered that some items would be of wide interest to delegates. During the twelve months reported upon, for example, developments in blast furnace practice had reduced the number of " slips " by 75 per cent.; diesels were rapidly displacing steam locos inside works; a cement company was confident that its emissions would comply with ordinances by 1st June, 1954; success in the control of burning pit heaps and prevention of combustion on those now in use; railroads within the county rapidly approaching 100 per cent. diesel; almost 100 per cent. gas firing of brick kilns, and successful methods of smoke prevention where solid fuels were used.

This was only one of many instances where he had obtained valuable information from the U.S.A. Unfortunately, when such information was quoted at meetings, gentlemen to whom they looked for guidance stated that the Americans were merely " shooting a line "—that in fact atmospheric conditions in the American industrial areas were as bad, if not worse, than those in Britain. However, the recent report of the Iron and Steel Productivity Team which visited the U.S.A. in 1951 emphasized the fact that heavy industry was concentrated in only a few areas of the U.S.A. For example, 90 per cent. of the steel production was in the area of the Great Lakes; in the Pittsburgh area alone, there were 35 steel plants which produced 21 million tons of steel in 1950. The steel production for the whole of Great Britain in the same period was 18 million tons. If what was inferred was true (namely that the Americans were doing no more than ourselves) then Pittsburgh must be subject to a permanent blackout!

Mr. Wilkinson remained convinced that the Americans were making much greater and quicker progress than ourselves, and put forward the tentative suggestion that, if the money could be found, considerable valuable information would be obtained from the visit to America of a team of people interested in air pollution prevention. In addition, he advocated regular representation of the Society at some of the American conferences.

A. C. Hazel (Hurseal Ltd.), speaking as an appliance manufacturer, drew attention to the fact that the Ridley Committee's report confirmed that the efficiency of the modern inset grate was increased if smokeless solid fuel was used. He pointed out that when these grates were first produced, and (incidentally they were produced as long ago as 1938) they were known as " smokeless fuel grates," and when they reappeared on the market after the war, they were again called " smokeless fuel grates."

Gradually the public got to appreciate the virtues of these appliances and because of periodic shortages of smokeless fuel, manufacturers had tended to indicate that these appliances could burn any fuel, which while strictly correct, the fact remained that if smokeless fuel was used, their efficiency was something like 25 per cent. higher than when burning bituminous coal.

The general public should be told of these important facts. Furthermore, Mr. Hazel went on to point out, the openable stove was very much more efficient than a modern inset grate and here, of course, to achieve the greatest efficiency and avoid any difficulties regarding chimney sweeping, the complete answer was smokeless solid fuel.

He went on to describe some developments taking place in improving the open fire and explained that the Ridley Committee had recommended the development of an open fire which should be a

sort of half-way house between an inset grate and an openable stove, and had an efficiency of not less than 40 per cent. on coal. The way one could increase the efficiency of open fires was to reduce the throat and control it by means of a flue damper, reduce the number of room air changes, provide a larger convecting surface by allowing air to circulate around the appliance, and provide radiation as low down as possible.

An appliance that complied with all this was already at the prototype stage. However, if one wanted to get higher efficiencies than this there was only one way to do it and that was by making use of the flue gases. Incidentally one of the points of this new design would be that the flue gases would have a higher temperature and therefore a higher velocity and they could therefore be made to travel around the flue ways, but this automatically meant smokeless fuel, otherwise the flue ways would become clogged with soot.

To sum up, Mr. Hazel emphasized that any developments for increasing the efficiency of solid fuel appliances in the home must automatically mean a greater demand for smokeless solid fuel and the public should be made aware of the fact that you only got these high efficiencies if you used smokeless solid fuel.

Dr. C. F. White (City of London) said that there certainly appeared to be a direct relation between the incidence of cancer of the lung and tobacco smoking. The general increase in the number of cases of cancer of the lung had run parallel with the general increase in the consumption of tobacco and the disease was most prevalent amongst heavy smokers, particularly of cigarettes.

But in regard to atmospheric pollution there seemed to him to be an inverse relationship so far as the general picture over the whole country was concerned. Though there was still much avoidable pollution of the air, conditions had improved greatly in the last 50 or even 100 years. If there was a direct relationship between cancer of the lung and atmospheric pollution the improvement in the latter should have been accompanied by an improvement in the former, whereas the reverse had been the case.

He welcomed any help in the campaign for smoke abatement, but he was not yet satisfied that they would be justified in saying anything about the increased incidence of cancer of the lung in their propaganda.

Dr. Stocks in his reply said that data were not yet available from cities in U.S.A. which would make it possible to decide how their death rates from cancer of the lung compare with those in English cities. For reliable comparison one must be sure that medical certification of this cause of death has attained about the same level of completeness in the two countries, and also be in a position to correct the rates for differences of age distribution in the populations. The World Health Organisation was working to improve comparability of death statistics but it would take time. It was important also to achieve some standardization of methcds of measurement of atmospheric pollution if the relative smokiness of towns in different countries, and indeed in the same country, was to be judged, and he urged that such work should be persevered with.

On the point raised by Dr. White, although most experts were agreed that the incidence of lung cancer was increasing, the rise in the last 20 years had certainly not been as pronounced as the death rates suggested. Cigarette smoking had increased very greatly whilst air pollution by other smoke had diminished quite appreciably; but a large increase in the effects of tobacco might have masked a diminution in the effects of other smoke. For example, it might be, and he knew no facts to disprove it, that about 1930 tobacco was causing 3,000 cases of lung cancer and other smoke 5,000 annually, most of the cases dying at an early stage with diagnosis of "pneumonia," whereas about 1950, 6,000 cases were being caused by tobacco and 4,000 by other smoke, most being saved from early death by infection and then recognised as bronchogenic cancer. With so much uncertainty about the real rate of increase of the disease, Dr. Stocks did not think the idea that the two factors were jointly concerned was incompatible with any facts so far established. Furthermore, a diminution in domestic and industrial smoke as a whole did not necessarily mean that the carcinogenic substances in the air of towns, whatever they were, had likewise diminished.

INCENTIVES FOR SMOKE PREVENTION

(I) INDUSTRIAL

by

W. L. Mather, M.C., T.D., M.D.

In trying to find the best incentives for the prevention of industrial air pollution it is necessary, first of all, to establish the causes of pollution, then see how these causes can be eliminated and, finally, to arrive at incentives to these methods of prevention.

An incentive is a somewhat individual thing, in that different people react differently to the same incentive but, generally speaking, the time-honoured "carrot and stick" can be applied in varying degrees to all of us.

Most forms of industrial air pollution could be prevented with relative ease and the real enemy is often apathy, or lack of interest, which being somewhat abstract, are more difficult to deal with than concrete problems.

There appear to be five main causes of industrial air pollution:

1. Fuel.
2. Boiler plant.
3. The people who operate the boiler plant.
4. The administration of the concern.
5. Special industrial processes.

Having established these causes, the second stage is to arrive at methods of preventing them, and these, in order, would be the following:

1. Where the fuel is at fault, to replace it by a more appropriate grade and, under present conditions, this is often difficult. However, I have found that if sufficient pressure is brought to bear, coal suppliers will often take a certain amount of extra trouble and, at least, a proportion of the right type of fuel can be obtained. Here, therefore, the forms of prevention are for the National Coal Board to make the right types of fuel available as soon as possible, and for the user to exercise more determination in obtaining the right type of fuel.

2. Where the boiler plant is the cause of pollution, it may either be that the plant is not properly operated and maintained or, that it is unsuitable for its present application. Surprisingly enough it is usually the former, and bad maintenance is often the principal cause of a smoking industrial chimney. In this connection, the Fuel Advisory Service, of the Ministry of Fuel and Power, are helpful. They are short-staffed and under-equipped, but they are doing most useful work, and they seldom do a survey without being able to show how a substantial amount of fuel can be saved with a corresponding reduction in pollution.

In the second instance, where the boilerplant is unsuitable for its present application, the only answer is to replace it by something which is suitable. With capital as tight as it is today, this naturally presents a serious problem; directors of companies have to be careful about capital expenditure, particularly if it involves an overdraft, so that although new plant may be more than justified they may feel better able to meet heavy maintenance expenditure as long as it is a chargeable expense.

3. Where the operators of the boilerplant are at fault it is largely due to ignorance or lack of interest. Stokers' courses are run at a number of centres, and where a boiler hand is sufficiently intelligent to take advantage of these, he should be encouraged to attend them. This raises special, and sometimes thorny,

problems. Many concerns employ only labourers in the boiler house, particularly if it is a plant which shuts down in summer. A man who acquires special qualifications may find he can get paid no more than labourers rate, and I feel that there is a good case for a skilled rate of pay based upon actual qualifications.

There are, unfortunately, some boiler hands who would find these courses too difficult and others who are too set in their ways to alter their methods. They were brought up under conditions very different from today, when there was a surplus of coal and a smoking chimney was a sign of prosperity. It is never easy to make die-hards change their ways, but in the national interest greater firmness should at times be exercised.

4. The administration of an industrial concern naturally has the most influence on the extent of air pollution. It is a sound maxim for any form of maintenance that "the machine is never wrong, it is the man that is at fault." Now this is always true, and will remain so as long as man is master of the machine and not the machine master of the man. It is important, therefore, that administrators should recognise this fact, and not be put off with the many excuses which they hear about "it" being at fault. It is up to them to see that they have the right fuel and plant and that their staff operate it correctly. They may encounter apathy, ignorance or opposition, and to overcome them the administrator must himself properly understand the economies of fuel as well as, one hopes, appreciating his sociological responsibilities. He will thus require knowledge, courage and enthusiasm for cleaner air.

5. Where a special industrial process is involved, special problems arise. Each process has to be taken on its merits, and can seldom be considered collectively. There is the problem of the chemical works, the blast furnace, the gas works and so on, and before deciding how the pollution, which they create, can be prevented, their individual circumstances must be investigated. However, the same factors generally apply to special processes, namely: the plant involved, the people who operate the plant and the administration of the concern. If they are all doing their work properly a minimum of pollution will result.

Having established the causes, and the methods which can prevent them, we must try to find the incentives which will encourage these methods to be adopted.

First of all, the availability of the right kind of fuel. This is really a matter for the Ministry of Fuel and Power, and the National Coal Board, and it is fair to say that they are both doing a lot to see that fuel is used in its most economical and satisfactory form. The only further action that can be taken is to give them support and encouragement in the hope that they will do even more.

There is also the possibility that the buyer himself may not always ask for the most suitable type of fuel, even though it is available, and some extra advice or an alteration in the price structure may then be desirable. The price structure is continually under consideration by the Society, particularly with regard to the domestic consumer, and it is a subject which should be kept well to the fore. It is interesting to reflect that whereas raw coal is regarded as being the secret of our economic life, and that, apart from food, is our most important raw material, at the present time it is one of the few commodities which escapes taxation, although by world standards the British price is low and we use twice as much coal per head of population as the average European. There is no quicker way of touching people than through their pockets, and a tax on raw coal could certainly make industry burn it efficiently or not at all.

The proper maintenance of plant is somewhere where the "stick" may have a greater application than the "carrot." People who maintain things badly are seldom unaware of the fact, and usually the best way to correct this state of affairs is by the use of the "stick," and it is here that the local authorities can play their part. If all local authorities would exercise the powers to which they are entitled, under the Public Health Act, then a great deal of bad maintenance could be prevented.

The replacement of obsolete plant, on the other hand, is a different matter as it involves special capital expenditure. The easiest incentive here would be to give special depreciation rates on plant which reduced atmospheric pollution such as modern boilerplant and, while this may appear to be unfair in that the efficient people who have kept themselves up-to-date would not draw the same advantage as the inefficient, it would perhaps be justifiable in the national interest.

Where the plant itself is correct and reasonably well maintained, but the operator works it badly, some form of incentive must be given to him. The

soundest way is that of education, because if people know of a better way of doing something, they will usually do it and if they do not, it is up to those who manage them to see that they do. An expansion, therefore, in the training courses for stokers should be an incentive, and if the trades unions concerned could give greater inspiration to their members, to become more skilled in their calling and, at the same time get agreement for that skill to be financially rewarded, fuel could be saved and pollution reduced. It must, however, remain for the management to encourage these courses, and to see that proper advantage is taken of them.

An incentive to make clean an industrial process, which is intrinsically dirty, is difficult to arrive at, and as I said before, each case must be treated on its merits. Here, it must be up to the local authority to investigate thoroughly, but fairly, the cause of nuisance in their area and, having established the reason, to exercise the necessary sympathy or severity.

We finally come to the incentives to be provided for the administrators. These are, perhaps, the most intangible because every administrator will have a different outlook, and his incentive will need to be equally different.

First of all, comes the incentive of knowledge, and this can be provided by the Fuel Advisory Service of the Ministry of Fuel and Power, and also by a sympathetic press. There is then the incentive of evident efficiency, and if a smoking chimney came to be regarded by all as visible evidence of industrial inefficiency, then many people who are at present disinterested, would make greater efforts to clean their local skies. Here again, the press can do much to help.

There is then the very practical incentive of the "stick," and were more fines levied upon offending firms, then unquestionably the administrator would see that there was less pollution. This is a problem for the local authority, and one which requires moral courage and determination.

Following on is the incentive of cost, and this is a combination of the cost of replacements to plant, which can be alleviated by improved depreciation rates, and the cost of fuel itself. The more fuel costs, the greater importance will be attached to fuel efficiency by the administrator.

However, I believe that sociological incentives could affect the administration most of all. If it were generally accepted that those who pollute the air were bad citizens and not respectable citizens, that to pollute the air was both selfish and dirty and that those who did it were liable to be classed as evildoers, then I believe that many of those responsible for our industrial air pollution would take a greater interest in preventing it.

Having considered the causes of industrial air pollution, the methods of preventing them and the incentives to get these methods adopted I would like now to summarize these same incentives:

1. *Knowledge.* The Fuel Advisory Service of the Ministry of Fuel and Power is helping to make the operation of boiler plant more efficient, and anything which can be done to expand their activities should be encouraged.

2. *The Full Exercising of their Powers by Local Authorities.* Local authorities usually either have, or can obtain, adequate powers to deal with atmospheric pollution. If they would exercise these powers, then the majority of industrial atmospheric pollution could be prevented. Perhaps the best way of bringing this about would be for some general directive from the Ministry of Fuel and Power, to local authorities, so that all would speak with a common voice, and those who exercised disciplinary action would not be criticized in comparison with their weaker brethren.

3. *Cost.* Despite the high cost of fuel, no one today pays the full cost of the pollution he causes. Anyone who did would find that pollution did not pay. The price of fuel should be adjusted, and depreciation rates on new plant arranged, so that a concern causing pollution bore the equivalent extra cost to the community itself.

4. *Good Citizenship.* If a moral stigma could be attached to those who pollute the air and grateful publicity be given to those who reduce pollution then much more energy and interest would be forthcoming for smoke abatement. Our industrial areas are the most polluted in the world, there is no practical reason why they cannot be made clean, the sole requirement is a belief in the need and the energy to carry it out.

There are obviously many incentives besides these four but I believe these to be the most important. And of the four I believe that stronger action on the part of local authority would be the most effective. The regulations exist—all that is required is courage and enthusiasm.

(II) DOMESTIC

by

W. R. Martine, O.B.E., T.D., M.D.(Edin.), D.P.H., F.R.San.I.

As a medical officer in the public health department of a very large local authority, it is inevitable that I should run the risk, in giving such a paper as this, of expressing views not necessarily approved by the Council I serve. My fellow members of the Executive Council of this Society may not, indeed, agree with me. I make it clear, therefore, that, whatever line I may take on this controversial subject, it is wholly my own, and, if provocative to some, so much the better, for the subject is most deserving of discussion in every possible quarter.

In considering domestic air pollution, our field is limited as compared with industrial pollution where problems arise from a variety of industrial processes, where each premises in an area may present special features, each requiring special and individual consideration. From that point of view I have the easier task, yet the question of incentives in the domestic field is so complex and so intimately bound up with education, as I shall attempt to elaborate, that I feel it would have been more appropriate for someone now outside the sphere of local government to be giving this paper.

My view is that incentives are desirable, if progress in the domestic field is not to lag still further behind industrial action, but as any incentive must inevitably be financial in character, many considerations must be faced. Successive governments in this country have clearly shown that if they have ever appreciated the problem of domestic smoke they have certainly not encouraged solution by way of incentive, certainly not financial incentive. That is not to say that individual ministers have not shown a genuine interest in smoke abatement—we have heard them at these conferences and some have spoken plainly enough in the House, but has it ever gone further, since the days of John Evelyn? The late Neville Chamberlain, when Minister of Health (and don't let it be forgotten that he was a member of the Birmingham City Council for many years before he entered Parliament) denied, in reply to a question, that cancer was the most frequent cause of death, and stressed that it was the respiratory diseases, particularly bronchitis, which sooner or later carried off the majority of the population in our closely packed built-up areas.[1] His warning, and those of many since, have not fallen on very receptive ears, for while some progress has undoubtedly been made in the reduction of industrial pollution, and while certain enlightened local authorities have striven for, and even obtained, means to reduce domestic pollution the open hearth burning raw fuel still holds sway in the hearts of men and women in this country, including the great body of those who have, over the years, represented them in the House.

Before the question of incentives arises, therefore, I believe it to be necessary for very extensive educational measures to be undertaken, commencing at the top, while at the same time a tremendous effort is being made to ensure a much more adequate supply of more suitable fuel than is available to the housewife today. Lord Simon, in his presidential address at Harrogate in 1949 instanced local authorities, architects and builders as in need of such education[2]: for myself I would extend the list by including all Members of Parliament, surveyors and housing managers, school teachers, parents and housewives. Education must come before understanding, and understanding is necessary, in my view, to justify incentive. How otherwise could people know what to instal, or how to operate it, once it has been installed. A representative of the Minister of Health at that same conference underlined the need for efficient operation of new equipment,[3] and rightly so—for without efficient operation there can be little economy of fuel, with no less smoke than before, and with a disgruntled house-holder to discredit our propaganda into the bargain. And again, no efficient operation of modern fuel-burning equipment will ever make up for lack of insulation in house-building or for faulty siting of heating units on the outside walls of houses.

The Need for Publicity

Publicity has always been our Society's main line of attack against the smoke

nuisance, and at the same time our greatest and most difficult problem. Never since my first connection with the Society in 1937, have we had sufficient financial support to enable us to state our case for clean air where, and how, and when we should have liked. There is still, therefore, a vast nation-wide ignorance, as expressed by the popular view that domestic smoke emission is negligible, or alternatively, harmless, and that our only problem is industrial. Those present who include smoke abatement in their syllabus of Health Education must, like me, have been struck by the complete lack of appreciation by the public that there could be any domestic side to the problem at all. I have found, too, that those who are most vocal in complaint against industrial smoke are themselves quite ignorant of the harm emanating from their own hearth, or for that matter, of the poor heating value they get from it. They blame the fuel, not the firegrate.

Only when public opinion moves more positively in the right direction and public demand begins to make itself felt, will there be any case for incentives in the domestic field, as far as I can see. Instead of immediate incentives, it is rather a policy, by way of smokeless zones, for example, which is required now, a policy capable of expansion and taking in incentive schemes to be put into effect at the appropriate time. Such a policy we know to be contained in the Simon Report of 1946, but response to the recommendations made have proved to be somewhat disappointing. It is only fair, however, to acknowledge the testing of new types of domestic appliance which has been so greatly extended at the Fuel Research Station at Greenwich, while other approved centres have been established to further this important work. The Minister of Health has thus been in a position to advise local authorities since 1948, and to issue to them details of appliances suitable for installation in new and reconditioned houses.[4] This policy was subsequently extended to include all new houses[5], but it has not yet, seemingly, been found practicable to implement the vital recommendation that manufacture and sale of new appliances, falling below approved standards, should be prohibited.[6] No explanation or reason has been given for failure to implement this basically sound recommendation, but I suggest that shortage of suitable smokeless fuel need not have been any deterrent. The modern type of approved appliance will in any event give a much more economic and efficient performance, whatever the fuel, and when installed with a back-boiler, or fitted to an existing back-boiler, it is possible, by judicious use of down draught, to burn the dirtiest fuel and slack smokelessly, provide hot water, and ensure all-night burning—and at the same time effect a very considerable reduction in the amount of fuel used as compared with the old-fashioned open fire.

The Housing Act of 1949 has also not been as helpful as we were led to believe it would be, when we listened to the Parliamentary Secretary, Ministry of Health, at Harrogate in 1948,[7] and I was in entire agreement with my colleague, Mr. G. W. Farquharson, when he expressed the view at Blackpool last year[8] that the Ministry had missed a glorious opportunity of paving the way to implementation of a major recommendation contained in the Simon Report, by not using influence to have the £100 minimum for improvement grant reduced, say, to £30, as an incentive towards the replacement of obsolete, uneconomic and inefficient heating appliances. Apart from that aspect, however, the provisions of the Act are bound by so many limitations that it has served to frustrate rather than encourage progress towards the efficient use of fuel and the abolition of domestic smoke. Replacement of the obsolete in the owner-occupied house could be brought about only by persuasion, and difficult as that sometimes was, it was harder still to persuade the private landlord, when he could get a return of not more than 8 per cent. per annum, while a tenant must be ever chary of spending money on appliances, etc., which, on installation, would become landlord's fittings.

Smokeless Zones

Some progress has, however, been made by way of the grant of powers to a number of local authorities to promote smokeless zone legislation. Twelve have so far secured such powers, and others are known to be following, while zones have actually been established in 1951 under the Coventry Coporation Act, 1948, and in 1952 under the Manchester Corporation Act, 1946. That there would be opposition to such legislation in certain areas was inevitable, and it is to the credit of the Nottingham City Council that they have been able to defeat local opposition by achieving what is, in effect, a smokeless zone without legislative powers. By imposing the use of smokeless fuel, in suitable appliances provided, as a condi-

tion of tenancy on a large new housing estate, the same result is being obtained. The opposition recorded in Hull, as coming from the representatives of property-owners' associations, merely serves once more to underline the need for education already referred to. Of all people, surely those who have to pay most dearly for the ravages of smoke should support the idea of the smokeless zone.

It seems astonishing that such a principle,[9] conceived as long ago as 1935 by our former Chairman, the late Charles Gandy, should only now begin to become fact, but war and post-war conditions were no doubt partly responsible for the delay, and Mr. Gandy was at least able to see some prospect of achievement before his untimely death.

In both the Coventry and Manchester Acts there is a clause providing some safeguard for the lessee or tenant who may incur expense in executing works or providing appliances required for compliance with a smokeless zone order, while, again, the local authority is given powers to assist wholly, or in part. Until it is more generally appreciated that it is fuel efficiency per ton of fuel consumed which really counts, it is too much to expect landlord or tenant willingly to finance the conversion from old to new appliances, including the installation of gas ignition, while the present cost of smokeless fuels is, meantime, a further deterrent. I agree, therefore, with Mr. Marsh in his view expressed at Perth in May this year,[10] that it would be sound practical policy for the cost of conversion in a scheduled smokeless zone to be borne by the local authority, but I believe it only right that such cost should be subsidised by Government grant.

Finally, I would advocate some form of financial incentive to those who play their part in eliminating domestic pollution. Whether by rates rebate or exemption from increased rating, or by income tax allowance in respect of expenditure on conversion, is clearly a matter for the financial experts to decide. As however the question of rate revision is believed to be imminent, it would seem appropriate to consider rate rebate or exemption from increase and if neither of these are proved to be practicable, provide the income tax relief, if necessary over 2-3 years, to encourage the householder, be he owner-occupier or tenant, to play his individual part in ensuring clean air and, thereby, a reduction in incidence of respiratory disease in this country.

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6 Domestic Fuel Policy: Report of Fuel and Power Advisory Council—H.M. Stationery Office, 1946, p. 33, para. 2(c).

7 Arthur Blenkinsop, M.P.—Proceedings of Harrogate Conference, N.S.A.S., 1949, p. 11.

8 G. W. Farquharson—Proceedings of Blackpool Conference, N.S.A.S., 1951, p. 83.

9 *Smokeless Air*, Spring, 1950, p. 76.

10 Arnold Marsh—Smokeless Zones: A review of the present position, 1952. (Paper read at Annual Conference of Scottish Division, N.S.A.S.).

Discussion

Miss Lovell Burgess (Lectures Officer, The Gas Council) opened the discussion by urging that local authorities, if they wished to provide incentives to further the cause of smoke abatement, should make it easy for their tenants to have alternative means of obtaining hot water in summer.

They had heard it said from practically all the speakers that smoke from domestic chimneys was a greater evil than industrial smoke. Surely it was time that Housing Authorities turned their tenants' attention from the fireplace (where, in grates designed to burn smokeless fuel, tenants continued, for the most part, to burn bituminous coal) when hot water was required in the summer, and during mild periods of the year.

While houses were being carcased it would be a simple matter for Housing Authorities to provide, by means of special wall fittings, for the cheap and easy installation of sink water heaters.

The speaker quoted from the *Daily*

Mail, 22nd September, an account of a meeting at which 300 Council tenants at Heath Park, Dagenham, had met to protest against the high cost of central and constant hot water as "an impracticable scheme for working class people."

A sink water heater gave hot water when required, and only when required. Unfortunately, the tenant had to pay the cost of its installation, which depended on the location of the gas pipe, and the extension of the gas and water pipes, and this, added to the price of the water heater, plus 66⅔ per cent. purchase tax, and the increased hire purchase terms, made a supplementary hot water supply almost prohibitive.

Certain Gas Boards, however, were prepared to install jigged wall plates—pipes located above the sink, projecting, but practically flush with the wall—and make the necessary extension to the gas pipe free of charge. The extension of the water pipe became then the only cost to the Housing Authorities, and this was negligible while the house was actually in course of construction. There was no capital expenditure for the Housing Authority, and the tenant who wished to do so could have a water heater fitted by unskilled labour in less than twenty minutes for a few shillings. If the heater was removed at any time the wall remained undamaged.

It was part of national fuel policy to encourage the use of coke as a smokeless fuel. Gas, also smokeless, was inseparable from coke ignition and coke production, and twice as efficient as any other secondary fuel in terms of coal consumption and coal utilization.

J. B. M. Mason (Powell Duffryn Technical Services Ltd.) said that he had recently returned from an extensive tour of Australia where he had been engaged in engineering work for various clients and had gained certain impressions which he thought would be of interest to the Conference.

1. He had expected, upon his return, to find that the certification of boiler personnel had made more headway in this country. In Australia a man, before being allowed to operate any kind of boiler plant, had to obtain a certificate of competence. Personnel were divided into three classes and were certificated according to their ability to operate certain plant. A primary certificate for those operating C.I. and low pressure boilers, an intermediary for boilers of the Lancashire type, and an advanced certificate for those attending high pressure water tube boilers. Mr. Mason felt that untrained stokers should not be allowed to operate what was really a form of lethal weapon and it certainly was not fair to the stoker's fellow citizens who had to put up with the smoke and filth which he made, and to the manufacturer whose equipment he so mishandled.

2. Few steps seemed to have been taken to clean up really black spots as railway locomotive sheds and intermittent brick kilns.

3. Although in legal parlance the term smoke meant fume and grit, sufficient emphasis was not given to the elimination of dust nuisance. Mr. Mason suggested that it was time that a really cheap dust extractor could be marketed.

4. The million pound loan established by the Ministry of Fuel and Power to assist manufacturers in the purchase of fuel saving plant would do little to create an incentive as commercial rates of interest would still have to be paid on money borrowed. It would appear that the only real way was for the Treasury to devise a scheme so that industrialists had not to pay such a heavy tax on the capital cost fuel saving equipment.

5. Although some incentive schemes for the better operation of boiler plant had been applied, only a few were working well, for after a time the boilerhouse personnel regarded the bonus as part of their wages. He preferred the incentive to be applied by the upgrading of trained boiler personnel.

6. As for the application of Prior Approval it could be a two-edged weapon unless authorities were careful to see that the advice given to industrialists was really technically sound.

7. He was surprised to see, in addition, that a worthwhile scheme had not been developed to discover the economics, from all angles, of a combined heat and power scheme for an industrial town. A central plant passing out steam and power to consumers who now operated small and often inefficient plants could do much to clean up our industrial smoke nuisances.

G. A. Hiller (Bolton) said that, in common with others in the large industrial areas, he was very concerned about the discharges from factory chimneys. The Conference had rightly taken an increased interest in the problem of domestic smoke, but it was to be hoped that the outcome would not be that a new fashion had been set and that the old problem was to

be forgotten. Both aspects must be dealt with with equal enthusiasm; until the public was better educated, more could be done by the permanent abatement of nuisance from one mill chimney than would accrue from a lot of talking to housewives about domestic smoke.

The main point in the afternoon's paper was the provision of incentives to fuel burners, and Mr. Hiller said that, in his experience, incentives for efficient fuel burning alone would be insufficient owing to the changing nature of atmospheric pollution. There was now less black smoke, but very much more dense grey smoke which meant heavy grit emission. Consequently, incentives should include financial assistance towards the cost of grit arrestation methods or, better still, coal should be cleaner and better graded.

Mr. Mather, replying to the discussion, said he had only one point to make. The application of bonuses depended very much on individual firms, and their effectiveness upon the way they were administered. Generally speaking, a properly run bonus scheme did achieve its object, and they were always worth considering.

POLLUTION PROBLEMS OF THE IRON AND STEEL INDUSTRY

by

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Professor of Fuel Technology, University of Sheffield

This discussion is confined to the pollution problems associated with the manufacture of iron and steel which arise from the production of smoke, fumes and dust in the course of the processes operated in the industry.

The problem of the elimination of smoke in combustion appliances is the common one associated with all industries that use fuel. There are particularly difficult features relating to the heating of steel associated with two unavoidable conditions, (i) that the metal must at times be heated up from cold in a furnace, the cold walls of which may chill combustible gases and produce smoke, and (ii) that the atmosphere in which particular types of steel may be heated must be of a character which does not impair the surface of the steel. Otherwise excessive oxidation and decarburization may occur, which can result in ultimate failure of the steel in service. Again, a heating process may be followed by rolling or other forming operations, or perchance pickling, and the character of the scale formed in heating must be of a specific physical character to be satisfactory. To safeguard this need the use of smoky atmospheres has been regarded as a beneficient condition. The smoke *per se* is not an essential requirement, but may be a consequence of the production of the required atmosphere. The subject is one of considerable technical complexity and is being studied at the University of Sheffield with the support of the Fuel Research Board and the Sheffield/Rotherham and District

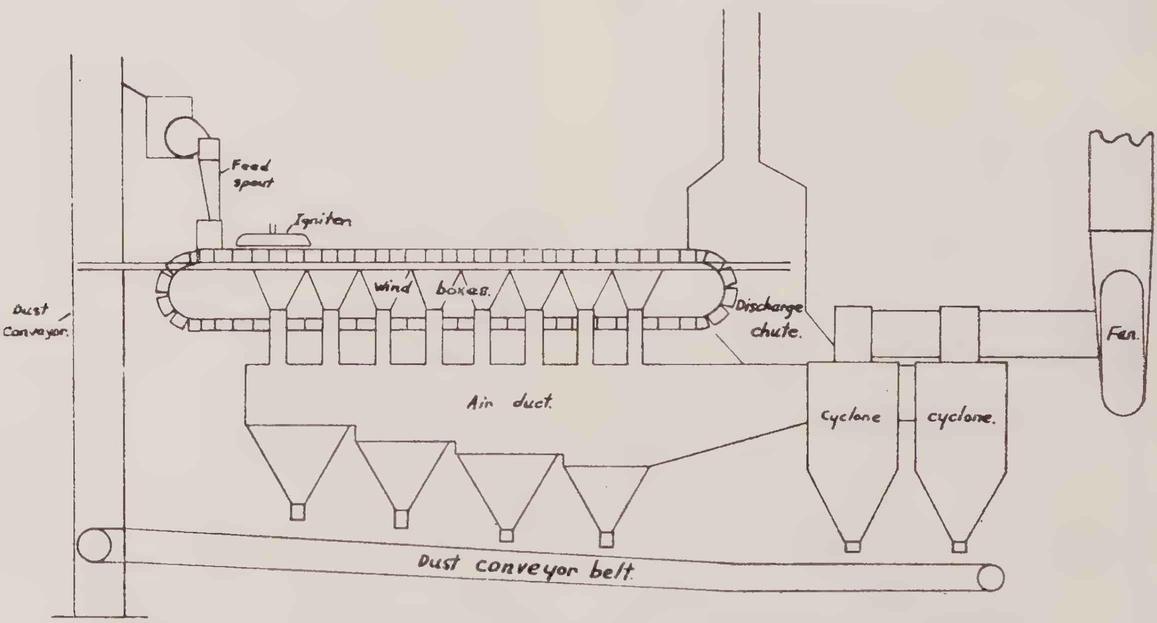

Fig. 1. Schematic arrangement of a continuous ore sintering plant.

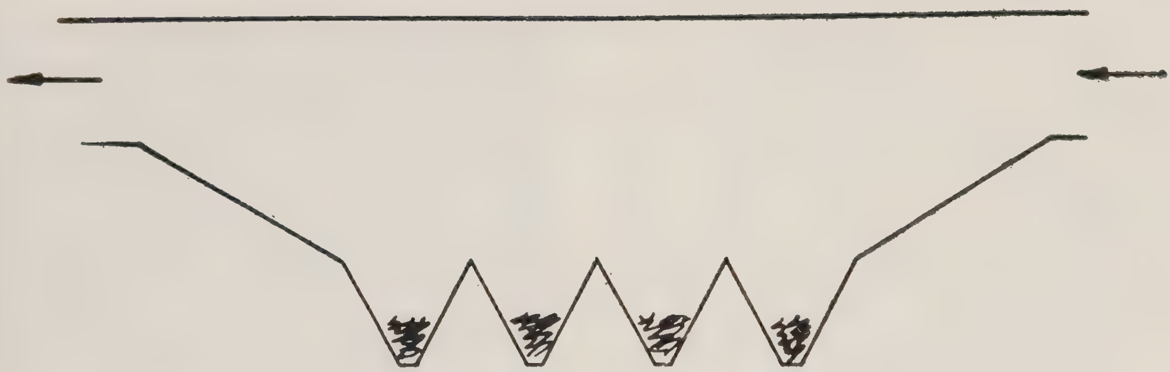

Fig. 2. Settling Chamber

Smoke Abatement Committee. The use of town's gas instead of raw coal may, in the case of certain steels and processes, be an effective means of eliminating smoke, but even in the use of gas technical problems arise in regard to the character of the scale, or the metal surface, which have not yet been entirely solved. The perfect answers may be provided in the use of controlled atmospheres in muffle furnaces, or in some cases in the resort to electrical power, as in the salt hardening of high grade tool steels. The economic question must ultimately arise and it may preclude the use of the most satisfactory technical method. This aspect of the subject, and the need to maintain a substantial export trade against keen competition looms up in almost every phase of the pollution problem.

It is becoming more widely recognized that much of the air pollution of industrial areas is caused by dusts and fumes that are not related to the combustion process. Such emissions are frequently an integral part of plant operation and for this reason may rarely be preventable by modified design or the care of the operator. Auxiliary mechanical equipment must then be necessary to remove the emissions. Economically the gain is to the community and not to the industry involved.

Blast Furnaces

The major unit in the iron industry serving as a potential dust producer is the blast furnace, in which may be used five tons of gas, capable of carrying a particularly troublesome dust, for every ton of iron produced. Yet it is fair to say that in the cleaning of blast furnace gas the technical difficulties have been overcome within the limits of economic possibility. The gas may be cleaned down to a dust content of only 0.002 grains per cubic foot. It is estimated that about one-tenth of the value of the blast furnace gas is spent on the removal of the dust. It is true also to say that a well-cleaned blast furnace gas has an increased availability and value in Cowper stoves for preheating the air blast for the furnace, in the production of power in gas engines, and in heating steelworks plant and coke ovens, whereby valuable coke oven gas may be made available for service of higher productivity.

Sintering Plants

Blast furnace dust contains certain amounts of iron ore and carbon, a typical analysis[1] for British practice being:

Fe_2O_3=25.6, CaO=7.1, MnO=7.9, MgO=1.1, Al_2O_3=10.0, SiO_2=19.3, ZnO=4.5, CuO=3.4, C=9.6, S=2.2.

For many years this dust was discarded. Now it is utilized to some extent. By adding fine ore it may be sintered, and made useful for recharging to the furnace. Sintering is the process of agglomerating fine particles into a porous mass by incipient fusion caused by heat generated within the mass itself. The heat is developed by the combustion of carbon in the form of coke breeze fed to the ore sintering plant (*Fig.* 1), to which air is supplied at a rate necessary to produce the sintering temperature. The circuit of air is downwards through the burden and leaves at the bottom through the grate. When fine materials are a major element of the sinter feed there is a troublesome proportion of dust in the stack gases, which have to be removed by means of collecting equipment.

Melting Plants

The dust emission from melting plants arises from the oxidation primarily of iron and to some lesser degree of manganese, and from the carry-over in the exhaust combustion gases in fuel fired furnaces of fluxes such as lime and limestone. In the electric melting furnace these fumes may escape through gaps in brickwork and at

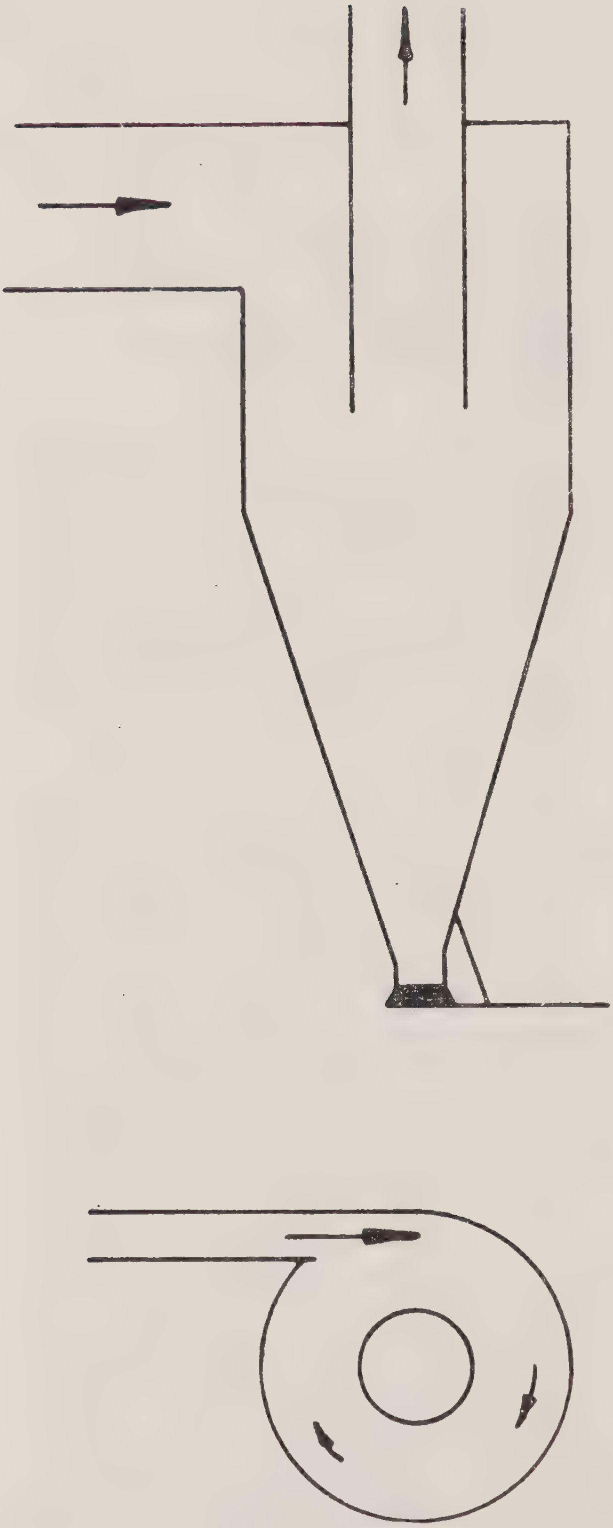

Fig. 3. Cyclone

door jambs. They are exhausted by means of fans placed in cowls over the furnaces. In the case of the open hearth furnace a considerable amount of dust is filtered out in the regenerator checkerwork used to pre-heat the air and gas, but the finer particles carried in the exhaust gas stream pass into the chimney exhaust system. Where waste heat boilers are used a certain amount of this gas collects in the boiler tubes, giving rise to the need for adequate cleaning at intervals. The fume from iron oxidation may be considerably increased if oxygen is blown into the molten bath with the object of speeding up the oxidation of the carbon and other constituents which have to be removed in the refining period. Another constituent of melting furnace fume which has in recent years been found to be a dangerous emission is fluorine produced from the fluospar used as a flux in basic furnaces. It has been found to contaminate pasture and to be harmful to cattle. The treatment of the chimney gases to remove solid constituents or sulphur dioxide has not been considered hitherto in this country to be an economical proposition in these processes. The tall chimneys common in such plants are normally regarded as being a sufficient means of dispersal of the emission.

The Bessemer Converter

The Bessemer converter is used on the largest scale in high output plants producing basic steel. In steel foundries, as an acid lined vessel, it is usually found as a much smaller unit. In both processes the effluent gases carry a copious brown fume consisting mainly of iron oxide. In recent years the use of oxygen enrichment has been practised in foundries, and then

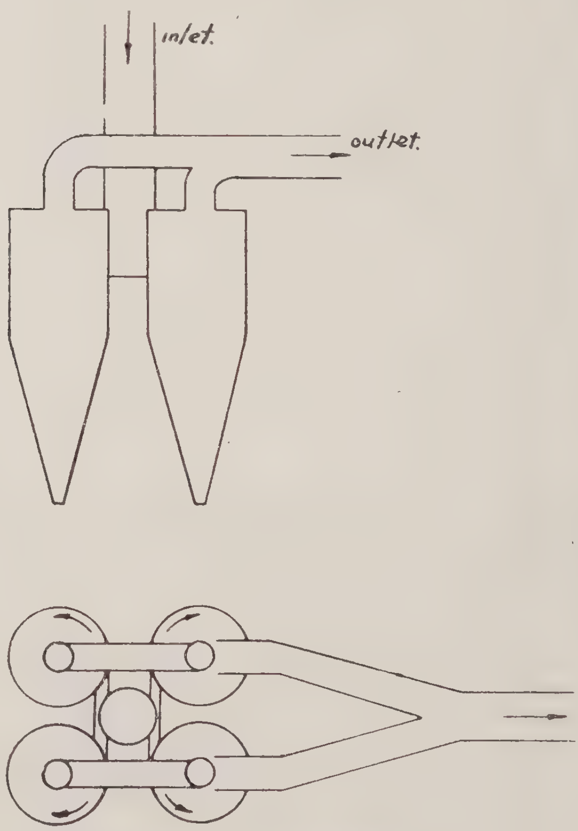

Fig. 4. Multicyclone

the dust emission has been considerably increased. Whereas in air-blown converters the hood gases may contain only two grains per cubic foot, with oxygen enrichment the dust content of the exhaust rises to five grains per cubic foot. The larger particles may be collected in a wet cyclone, but the removal of the smaller particles below 6μ may prove to be a much more troublesome matter. The problem of removal of the dust becomes a more diffcult one economically as the units may be small and their action, particularly in regard to the incidence of oxygen enrichment, may be of an intermittent character. Investigation of this problem also has been in hand in the Department of Fuel Technology in the University of Sheffield.

The Cupola

The cupola, used for melting cast iron or converter iron, emits hood gases that contain varying amounts of iron oxide and silica, together with lesser proportions of other metallurgical oxides and unburnt carbon monoxide. The dispersed character of this type of equipment and its generally limited size may explain why this particular type of plant is regarded as much less of a nuisance. In a foundry the control of dust emission from grinding plant and more particularly from fettling equipment constitutes a much more serious matter which has come under the operation of the Factory Act. Accordingly, since these problems in this particular industry must have attention according to the magnitude and deleterious characters of their effects, the emission of the cupola has become to be regarded as much the lesser evil.

Dust Removing Plant

The type of equipment suitable for collection of the deleterious emissions described obviously must vary widely with the problem. Briefly, the numerous types of equipment available for the purpose may be recognized as falling into five main groups: (1) Settling chambers, (2) cyclones and baffle chambers, (3) wet scrubbers, (4) filter bags, and (5) electrical precipitators.

Settling Chambers (*Fig*. 2) are the simplest and most economical type for separation of dust particles from the gas stream, provided the particle size is larger than 150μ. Settling chambers have low pressure losses and usually chimney draught is adequate for their operation. The real problem arises, however, with much smaller particle sizes.

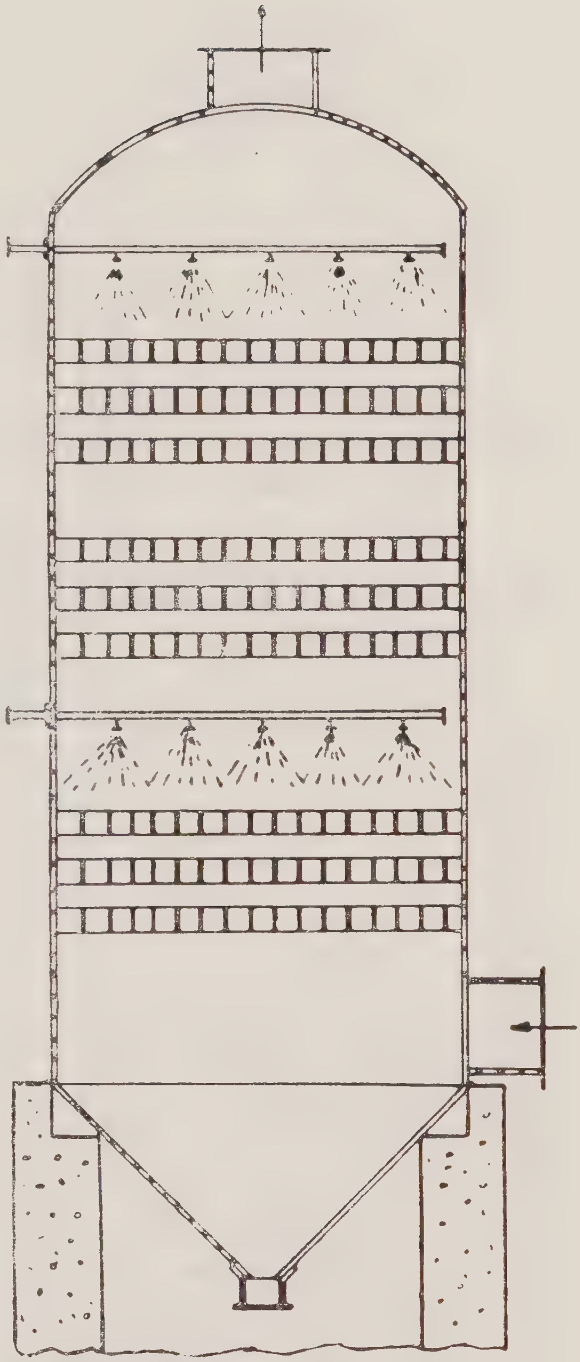

Fig. 5. Static scrubber with water spray

Cyclones (*Figs*. 3 *and* 4) are much more effective. The main factor that controls the collection efficiency is the diameter of the cyclone. A smaller unit working at a given pressure drop has a higher efficiency.[2] Accordingly they are used in parallel to give capacity. Reduction of the diameter of the gas outlet duct will increase efficiency of collection at the expense of pressure drop. An elongated rectangular section in the inlet duct, and a long cyclone is to be preferred.[3] The appliance will operate equally well on the section or pressure side of a fan. The efficiency

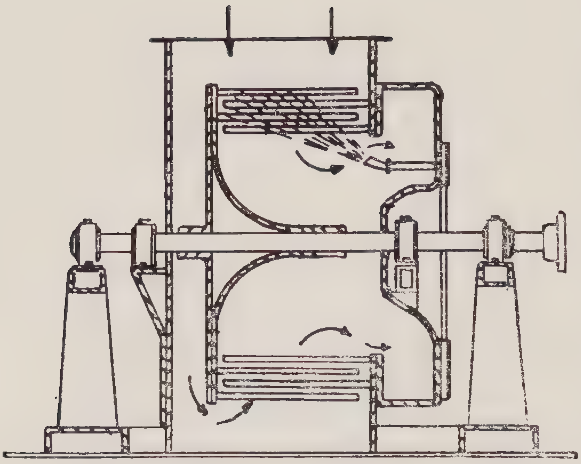

Fig. 6. Mechanical scrubber

obtained varies widely with the conditions of operation. A wet cyclone may have obvious advantages.

Filter Bags do not effect, as their name implies, a simple filtration since the pores in the cloth are many times the size of the particle separated. The efficiency of separation is, therefore, low until sufficient particles have been collected to reduce the apertures. They offer a high draught resistance but are extremely effective. Thus with a pressure drop of 10 in. w.g. the dust concentration can be reduced from 1 grain per cubic foot to about 0.008 grains. The older materials were limited to use at temperatures below 200° F. and they could not withstand the action of acidic gases. A new material, superior in these respects, consists of glass fibre cloth.

Wet Scrubbers are used in many different forms, namely, static scrubbers, tower sprays, wet cyclones, mechanical (*Fig.* 5) and venturi scrubbers. In the mechanical scrubber (*Fig.* 6) the centrifugal action of fan blades or perforated drums produces an intimate admixture of fine water spray and the gas. The power consumed is high, of the order of 10 h.p./1,000 cu. ft. per minute.[4] In the venturi scrubber[5] the gas is passed through a venturi at a velocity of 300 ft./sec. and water is injected into the gas stream through a series of jets which surround the throat. The effectiveness of the wet scrubber (*Fig.* 7) depends upon its capacity to wet the dust. Where fine water sprays are involved the gases must be passed through a dry cyclone or a suitable spray separator. The water availability frequently becomes the determining factor in the selection and economy of such methods.

Electrical Precipitators (*Fig.* 8) are the most effective means of removing industrial dusts from gases.[5] The charged particles are deposited on the earthed electrode and ultimately removed by shaking (*Fig.* 9). The efficiency of the plant depends on gas velocity, applied voltage (of the order of 50,000 volts) and the dimensions of the electrodes. The method is capable of cleaning gas down to a dust content as low as 0.002 grains/cu. ft. Since the capital and running costs are relatively high its use is generally limited to cases where the amount and value of the recovered products are large.

Applications in the Iron and Steel Industry

In blast furnace practice the pursuit of better methods of gas cleaning goes on continuously, if only for the reason that the very fine dust contained has a high nuisance character in the distribution and use of the gas. For the most effective cleaning of the gas a suitable sequence of dry dust settler, wet scrubber and electrical precipitator may produce successively concentrations of (i) 10 dropping to 4, (ii) 4 to 0.3, and (iii) 0.3 to 0.002 grains/cu. ft.[6]

In the case of the open hearth the venturi scrubber, followed by a spray separator has been used with a collection efficiency of 95 to 98 per cent. The water consumption is of the order of 4 gallons/

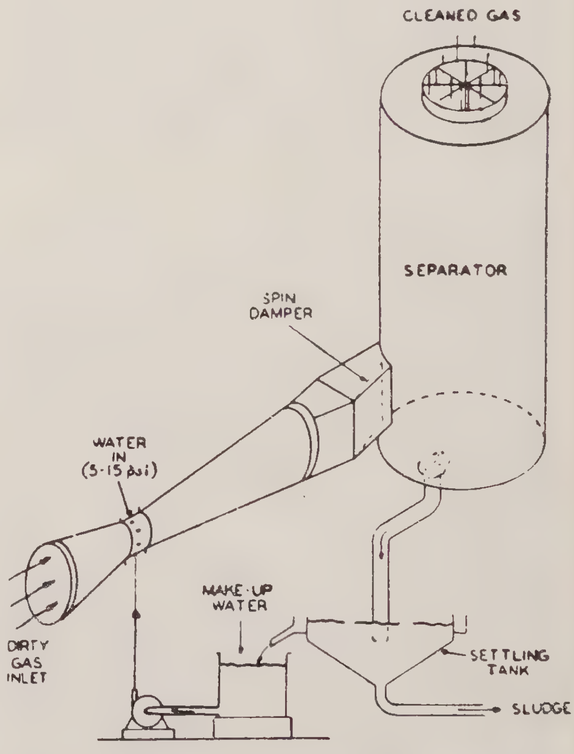

Fig. 7. Venturi scrubber with separator

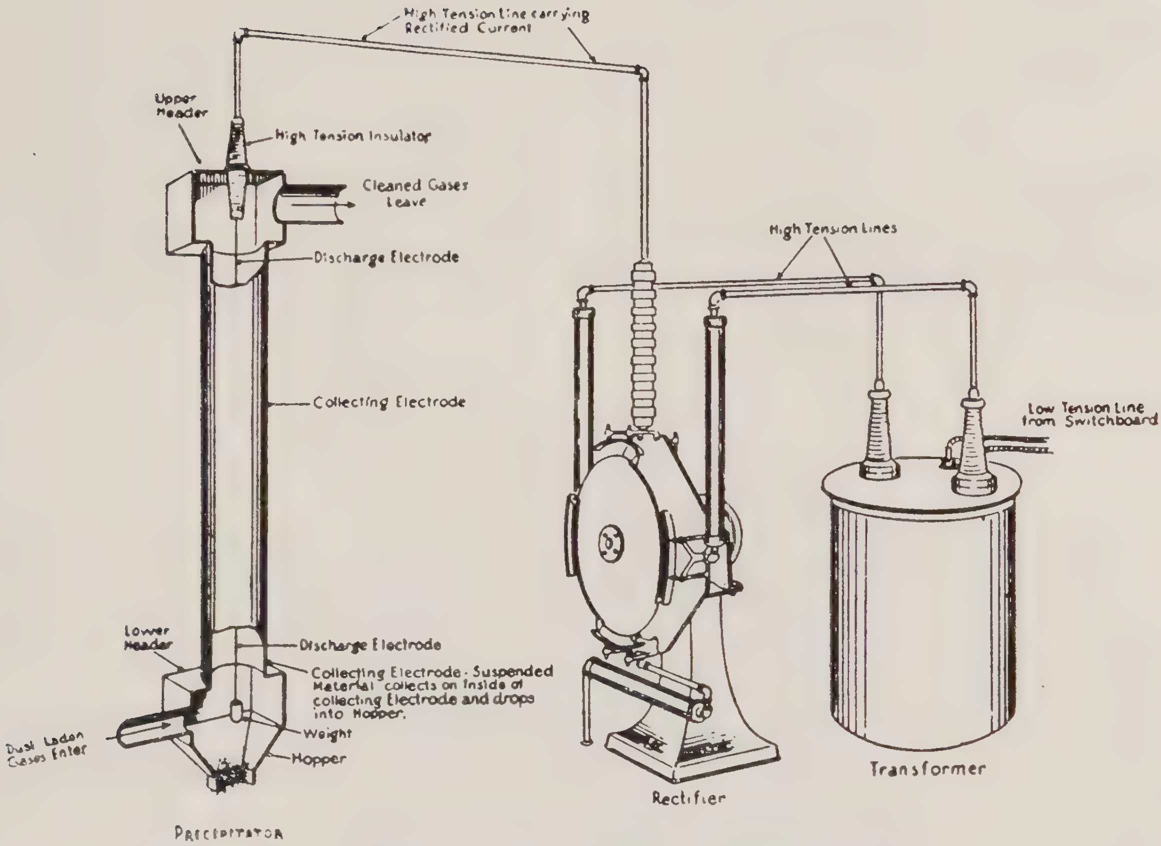

Fig. 8. Principle of electrical precipitator

min./1,000 cu. ft., corrected to 60° F. In the case of the cupola[7] gas cleaning plant has been applied. The cupola top was fitted with a charging bell and the waste gases were directed through a dry cyclone into a wet washer. By this means from 11-15 lb. of dry dust per ton of iron charged has been collected.

The Present Position

In all these processes the economic situation emerges as the prime factor in dust control. Looking at the problem from a national and unbiased viewpoint, two opposing major considerations appear, one based on the need for effective and economical manufacture of exportable products, and the other on the need for the suppression of dangers to health and well being of the worker and the citizen. The theme that both should be the aim of technical progress would receive universal acceptance. Where technical progress has provided the solution but the question of its application is limited by economical considerations, the interpretation of what must be regarded as economical depends upon the relative importance of the two considerations, the final cost of the product, and the degree of danger to health in prevailing practice. As to what should be the final judgment in a given case, decision must always depend upon the merits of the individual circumstances. No general rule of guidance can be laid down, even from the technical view point. Further, there are external remedies that are receiving more and more consideration as time goes on. The segregation of industrial and residential areas provides a case in point. If steel works and cottage stand side by side the obvious remedy is to remove the cottage. Where circumstances have produced a growth of industry and in near proximity the concurrent increase in density of population, the responsibility for the consequent evils of the type being discussed cannot be laid at the door of either the industrial pioneer or of the citizen seeking employment. Provision of a remedy would appear to be a joint responsibility. At a meeting such as this the scientists and engineers can debate the possibilities of their contribution and the town planning authorities the scope of theirs.

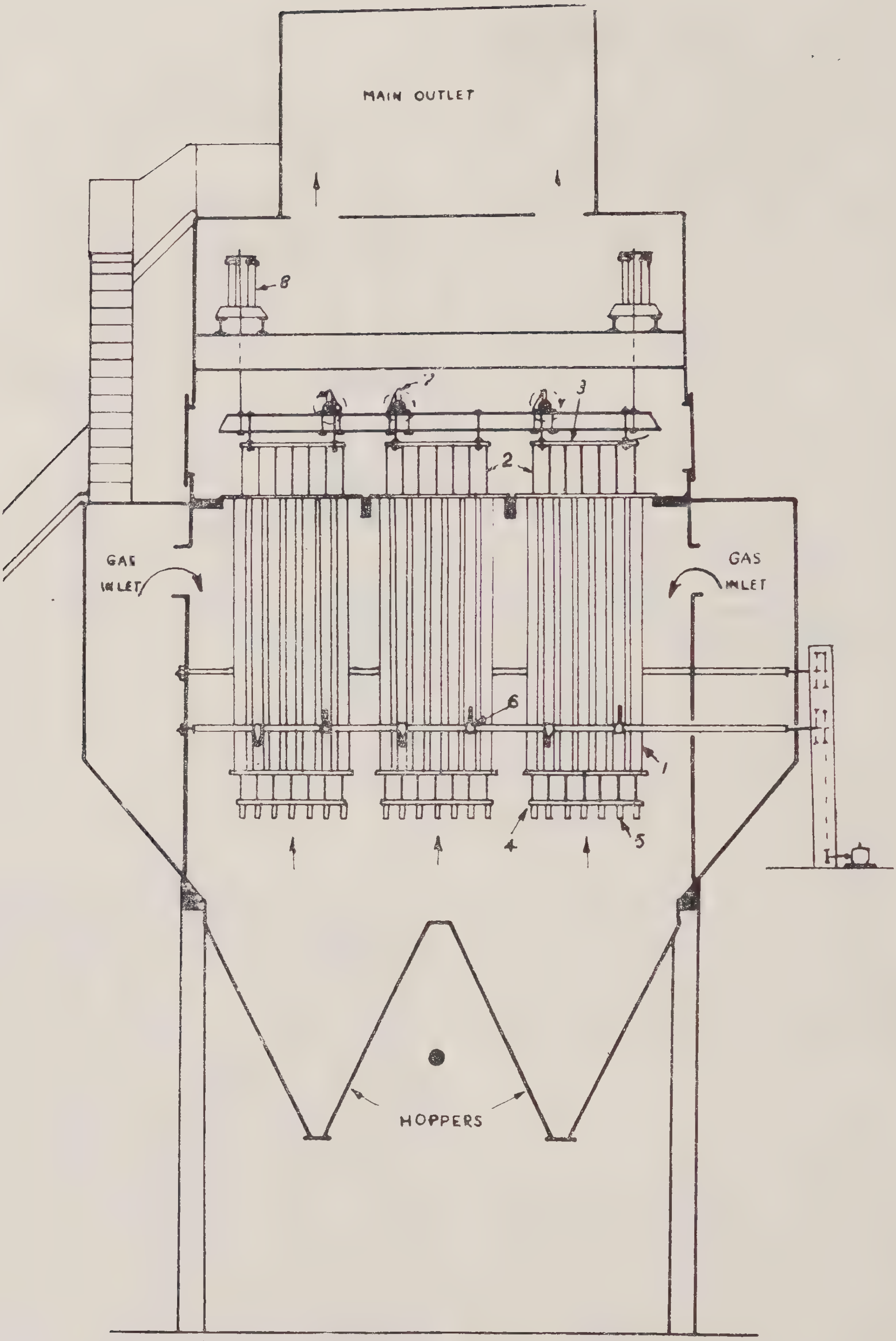

Fig. 9. Schematic arrangement of electrostatic precipitator plant

1. Tube Banks
2. Discharge Electrodes
3. Top Grids
4. Bottom Grids
5. Weights
6. Receiving Electrode Rapping Gear
7. Discharge Electrode Rapping Gear.
8. H.T. Insulators

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Discussion

James Law (Sheffield) stated that in taking part in this discussion he wanted to thank Professor Sarjant for a concise and well-balanced paper, giving details of the various forms of nuisance occurring at steelworks, but to express the disappointment felt by many on his conclusion, where he left it to the scientists, engineers and planners to decide the practical remedies and solutions.

He had hoped that after the amount of thought and energy he and his staff had given to the subject, he would have stated that the steel industry—which prided itself on being progressive—should, in the interests of the health of its workpeople, make suitable provision to eliminate the fumes and dust created in the fabrication of the materials.

Since 1875—a period of 77 years—the steel industry had enjoyed a privilege that had not been granted to any other industry—a provisional exemption of pollution of their process furnaces from the Public Health Act, 1936. There was a time when considerable doubt existed with regard to the necessity of a smoky atmosphere in furnaces, but it could be agreed today that such a necessity did not exist. This had been brought about by the persistence of the Local Authorities concerned, rather than the manufacturers themselves. In 1926, when a new smoke abatement bill was before Parliament, the exempted processes were extended provisionally for five years so that investigation of conditions could be made. In 1938 the Investigation Committee were satisfied "that provided suitable heating appliances were installed, there was no necessity for any further exemption," but a period of ten years was necessary for reconstruction to be carried out. The war intervened, and many obsolete furnaces were again put into operation and continue to this day.

In addition, melting processes had developed considerably and with them, other forms of pollution had taken place as described in Professor Sarjant's paper.

The use of oxygen in melting and refining had added considerably to the amount of impurity and solid matter emitted to the atmosphere. It had not been denied that this impurity could be suitably arrested, but the steelmakers were not going forward with such remedial work, on account of the additional cost, from which no return could be expected.

Three years ago the Iron and Steel Federation became members of the National Smoke Abatement Society in order to assist with their technical advisers in helping to reduce atmospheric pollution. That gesture had been welcomed by most of the members of the Society, and they were then asking them to show their sincerity as members by taking the necessary steps to clean the atmosphere, and to agree that the existing legislation granting provisional exemption was unsound, was not progressive, and should be deleted from the Statute Book.

Professor Sarjant had stated that "if steelworks and cottage stand side by side, the obvious remedy was to remove the cottage," but Mr. Law was asking in all sincerity "Did that remove the dust nuisance?" and he stated that Professor Sarjant knew as well as he did that it did not. Pollution knows no boundaries and is carried by the wind for many miles, the only solution being to arrest the dust and not allow it to pass to the atmosphere.

He thought the answer to that problem could be found in the introduction of Professor Sarjant's paper where he stated

"It is becoming more widely recognized that much of the air pollution of industrial areas is caused by dusts and fumes that are not related to the combustion process. Such emissions are frequently an integral part of plant operation, and for this reason may rarely be preventable by modified design or the care of the operator. Auxiliary mechanical equipment must then be necessary to remove the emissions."

As an engineer and one interested in Town Planning, though rigid zoning was an essential feature in steelworks practice, the collection of dust from melting and abrasive dust from grinding was imperative, if the welfare and health of steelworkers and the citizens was to be sustained.

He didn't expect that Professor Sarjant wished to be drawn into an expression of opinion with regard to the deletion of the metallurgical section from the Public Health Act. He said that he had given us a pointer with regard to it, and as there were many representatives of the steel manufacturers present, they would welcome candid criticism on that long-standing vexed question.

The best thanks of the Conference were due to the Professor for his concise paper, which was appreciated, and if he had quoted a context of his paper only, it had been done with a purpose.

Dr. T. P. Colclough (British Iron and Steel Federation) said that in the paper on "Incentives for Smoke Prevention" it was stated that "most forms of industrial air pollution could be prevented with relative ease, and the real enemy is often apathy." While this might be, and actually was, applicable to many forms of industry in which the cost of fuel was a relatively small factor in the total cost of production, it was certainly not applicable to the iron and steel industry, in which the cost of fuel used may amount to as much as 25 per cent., and in some special cases over 50 per cent., of the total cost of materials used. The efficient use of fuel with its corresponding diminution of smoke production was a vital part of the economy of iron and steel production, and as a result, a constant battle was waged against inefficiency which is manifest in visible form as smoke.

While Professor Sarjant had dealt adequately with the sources of smoke and dust which arise in steelworks and the methods which had been adopted to minimize the emission of these materials, the magnitude of the problem might not be commonly understood. The present development of the steel industry was leading to the establishment of integrated units each with a capacity of 15,000 to 20,000 tons of ingot steel per week. In one works of this type the amount of material to be handled, some of it several times over, amounted to between 200,000 to 250,000 tons per week. The mere fact of handling and transporting these materials inevitably created dust. In addition, in a modern integrated plant containing coke ovens and blast-furnaces, the amount of gas generated for every hour of the week amounted to about 2.5 million cu. ft. of coke oven gas and 20 million cu. ft. of blast-furnace gas. Forty years ago, a great part of this dirty blast-furnace gas was discharged into the atmosphere, and much of the coke oven gas was inefficiently used. Today, equipment had been developed and installed whereby the whole of these enormous volumes of gas were thoroughly cleaned until they were cleaner than the ordinary atmosphere, and were burnt under regulated conditions to eliminate almost completely the formation of smoke. It should be realized that while in some cases the dust or smoke nuisance still existed, this represented only a very small fraction of the total nuisance which would exist if these very efficient means for correction had not been applied.

A very good illustration of the progress which had been made was furnished by the new methods of making sheet and tinplate. Until recently, all sheet and tinplate was made by a process which involved heating the steel two or three times in a deliberately smoky atmosphere. As a result of intensive research work, highly elaborate machinery had been installed at a very high cost, which had removed the necessity for the smoky atmosphere, and the rolling and annealing of these materials was now carried out in atmospheres almost completely free from smoke.

Although much has been done, much still remained before the desired standards could be fully attained. Every modern steelworks had its own special officers for the control of combustion and dust-making operations. Bands of research workers were continuously employed in the solution of the problems, and it was absolutely certain that continuous improvement would be attained. This process might be accelerated by close and

sympathetic co-operation between the industrial producers and the local authorities, and it might be taken as axiomatic that constructive suggestions would be heartily welcomed by the companies engaged in this struggle.

T. Henry Turner congratulated Sheffield University for being the first to take a practical interest in smoke abatement and hoped that the academic staffs of Birmingham, Leeds, Glasgow and other universities would show that they also could initiate scientific moves to save themselves and their fellows from coal grime.

The iron and steel industries now made much less dust and smoke per ton of saleable product, but the output of steel per annum increased, and the dust and smoke nuisances in certain localities could not be accepted as long as permissible in a country with a national health policy.

He had been shown the cleanest of iron blast furnaces and cast-iron foundries in Detroit, and observed wheat growing beside an efficient blast furnace in Upper Silesia. These foreign examples of freedom from dirt around ironworks seen twenty-five years ago encouraged one to regard smoke and dust control as achievable in the iron and steel works of this country.

He would like Professor Sarjant to strengthen the section of his paper which dealt with cupolas. The very numerous cupolas used for melting cast iron were to be seen, for example, in almost every large engineering works where they produced much grit, at a low height of emission, which fell on the works and surrounding property. Cupolas were generally surrounded by numerous people per acre, and so their dust and fumes were felt as a nuisance by many people. The cupola dust blown over and into engineering works must increase the maintenance costs of workshops, as well as impair the health of workpeople.

The sulphur dioxide emitted from cupolas accelerated the corrosion of steel exposed in the works, such as railway lines, raw materials and scrap, creating iron oxide dust from that steel which became another nuisance.

Such a discussion should indicate what should be done. The N.S.A.S. already received welcome subscriptions from five well-known steel works whose far-sighted directors had decreed that whenever their design staffs submitted plans for future extensions or modifications such plans must be accompanied by a memorandum dealing with smoke and dust abatement. Thus these social minded and progressive steel firms have of their own initiative instituted "prior approval," although that is not required of them by law. This fine example deserved emulation by all iron and steel makers and users.

N. H. Turner said he had the opportunity of presenting a paper at the Blackpool meeting last year on the subject now dealt with by Professor Sarjant, and therefore, having already given his views, he would not occupy much time.

He rather regretted that Professor Sarjant had not considered the emission of smoke, dust and grit from iron and steel works under two headings: from those works grouped around Sheffield mainly producing steel, and from large integrated iron and steel works. With the latter, the question of smoke emission due to cooling of the gases before the combustion was completed did not come into the picture, as they were mostly using blast furnace gas as fuel and generally dealing with hot material.

With regard to dust and grit emission, he regretted that Professor Sarjant had not drawn attention to one of the main difficulties the large iron and steel works had to deal with. This point had been touched upon by Dr. Colclough, and he had already mentioned it last year, i.e. the difficulty of having ancillary equipment which could cope efficiently with the problem under all conditions. The amount of dust to be collected was very large, and they would appreciate that variations could take place over a very wide range with resultant variation in the efficiency of operation of the equipment involved. One thing, however, was almost certain, that when a new plant was put down, care was taken to prevent, as far as possible, dust and grit emission. He knew that some of their friends there might have doubts as to the effectiveness of the equipment used, although he hoped they would remember that progress was not always to be judged solely by the results achieved, but also by the rate at which it proceeded.

Dr. Sarjant, replying to the discussion, said, with reference to Mr. Law's remarks, that the paper was intended to be an introduction to a discussion, and therefore the statement of the problems to be tackled rather than an exhaustive exposition of a solution. Dr. Colclough's valuable contribution was in many respects an answer to Mr. Law's challenge.

If, as Mr. Law had indicated, the

author had stated categorically that the iron and steel industry should " make suitable provision to eliminate the fumes and dust created in the fabrication of the materials," would such a statement have solved a single problem ? It had been clearly stated that technical progress had provided solutions to a number of specific problems associated with atmospheric pollution from iron and steel works, but that economies could not be ruled out in seeking a satisfactory fulfilment of any application. It was the function of the scientist to provide the scientific data upon which the engineer could work to reach such an objective. It was for the economist, the politician, and, maybe, the planner to settle the phases of the problem which rightly came within their sphere. Mr. Law would appear to be wishing to entice the scientist into that dangerous field of controversy which was not his arena. Some heads might fall in the mêlée. The author would not venture to suggest whose.

If the paper had been intended to discuss recent scientific progress on this subject, it could not have been completed adequately in the brief space of time allowed. From the author's own experience, it could have covered much effective advancement. It was a characteristic feature of such progress that as fast as one set of problems became solved new ones arose. A concrete example might be cited from Mr. Law's own reference to the fume emission from the use of oxygen in melting processes, a problem on which they had worked together.

The author was indebted to Mr. Law for raising so many important questions. He would certainly agree that the all-important principle was to seek to prevent a nuisance at the source. It was to that end that the main objectives of the research on which they had been engaged in Sheffield had been directed.

In assessing the contribution made by industry a realization of the situation would be apparent from Dr. Colclough's telling point that the present pollution represented only a small fraction of the total nuisance which would exist if the preventive methods that had been made had not been applied.

Mr. T. Henry Turner had directed attention to the nuisance arising from the small cupola situated in congested districts. Here was a problem to be labelled economic rather than technical. Throat gases could be washed for oxide fumes and sulphur dioxide, but at what cost in such a possibly intermittent process ? Could the process survive the cost ? A high chimney to disperse the emission might prove to be an economically possible palliative in some circumstances.

Mr. N. H. Turner had postulated a line of approach to the subject which had been touched upon, but obviously not developed due to limitations of time. The Sheffield problem had a technical and metallurgical character quite distinct from those of the integrated steel works. The author would agree that it was not always easy to design cleaning plant which would be equally efficient under variation of load. Such a plant might be able to clean down to an adequate standard if not pushed beyond its rated capacity. The importance of anticipating accurately the realizable load on a new plant when the scheme was being developed on the drawing board was emphasized by Mr. Turner's remarks.

The effectiveness of the discussion had been very gratifying to the author.

RESOLUTIONS

During the Thursday afternoon session of the Conference the following resolutions were proposed and were unanimously agreed.

1. THAT this Conference welcomes, among other proposals that will promote smoke prevention, the recommendations of the Ridley Committee for the setting up of further smokeless zones and the increased production of solid smokeless fuel. Accordingly, and in view of new evidence that the dangers to health from domestic smoke may be greater than have previously been recognized, the Conference urges the Minister of Housing and Local Government to grant permission for the establishment of proposed smokeless zones; urges the Minister of Fuel and Power to do everything possible to develop the availability of smokeless solid fuel of all kinds for domestic purposes; and invites all local authorities to support these requests.

2. THAT all persons who have charge of the operation or maintenance of power plant, whether steam, oil, gas, or electrical, should possess sufficient theoretical knowledge and practical experience, eventually to be recognized by the holding of a certificate, to ensure that such plant shall be worked with maximum efficiency and safety.

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The Society's Publications

This is one of the many publications of the National Smoke Abatement Society. For a complete list write to the Society for its current Year Book. This contains a Guide to Publications on Smoke Prevention and Allied Subjects, which includes, in addition to the Society's own titles, particulars of other books, reports and papers, any of which may be purchased from the Society. The list is classified according to subject—the Law, Conference Proceedings, General, Historical, Smoke Prevention Administration, Industrial Smoke, Domestic Heating, Technical and Scientific, and Industrial Pollution.

NATIONAL SMOKE ABATEMENT SOCIETY

Proceedings of the 20th Annual Conference Glasgow

30th September to 2nd October, 1953

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30 Grosvenor Place, London, S.W.1.

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Glasgow Conference

SUMMARY OF EVENTS

The Right Honourable the Lord Provost of Glasgow, Thomas A. Kerr, Esq., welcomed the delegates and officially opened the Conference on Wednesday morning, 30th September, 1953. After the opening ceremony Alderman Professor F. E. Tylecote gave his Presidential Address, choosing as his subject " Smoke and the Local Authority."

The Fourth Des Voeux Memorial Lecture was presented on the afternoon of the same day by Sir John Charles, Chief Medical Officer, Ministry of Health. The subject of the lecture was " Air Pollution in Relation to Preventive Medicine." The chair was taken by Mr. S. N. Duguid, Chairman of the Executive Council and a vote of thanks to the lecturer was given by the Medical Officer of Health for Glasgow, Dr. Stuart I. A. Laidlaw. A reception on the same evening was given by the Rt. Hon. the Lord Provost to the delegates and their friends with dancing and entertainment in the Banqueting Hall of the City Chambers.

The session the next morning was under the chairmanship of Bailie J. H. P. Taylor, President of the Scottish Division of the Society and the delegates were given reports on the London Fog Disaster by Dr. J. A. Scott, Medical Officer of Health, London County Council, Dr. A. Parker, Director of Fuel Research, Department of Scientific and Industrial Research and Mr. Arnold Marsh. These were followed by a report on Smokeless Zones by Dr. T. M. Clayton, Medical Officer of Health, City of Coventry.

Solid Smokeless Fuels were the subject of the papers presented on that afternoon. There were two papers, one on the production and use, and the other on availability and distribution, each given by a panel of three and four authors respectively, and arranged by the Solid Smokeless Fuels Federation. The Chairman of the Scottish Fuel Efficiency Committee, Sir Patrick J. Dollan, presided during the afternoon.

The last paper of the Conference was presented on Friday morning by Mr. K. H. Sambrook on the Efficient and Smokeless Combustion of Fuel Oils with Mr. John Innes, Vice-President of the Scottish Division of the Society in the chair. During the course of the Annual General Meeting which followed this session the newly-elected President, Sir Ernest Smith, was introduced to the delegates. The Chairman of the Conference Committee, Mr. J. J. Matthews, proposed the vote of thanks at the conclusion of the Conference. Those included in the vote of thanks were the Right Honourable the Lord Provost and the Corporation of Glasgow, the authors and sessional chairman, the officers and staff of the City Chambers and the members of the Conference Committee.

By invitation of the North of Scotland Hydro-Electric Board a large number of delegates visited the Loch Sloy Power Station and Dam on the afternoon of Friday, 2nd October, 1953.

Presidential Address

SMOKE AND THE LOCAL AUTHORITY

by

Alderman Professor Frank E. Tylecote, M.D., D.P.H., F.R.C.P.Lond., J.P.

Early History—Manchester as an Example

Mr. Chairman, Ladies and Gentlemen:

Some months ago your Secretary suggested to me that this address should deal with " Smoke and the Local Authority." I then began to look into the early history of the concern of Local Authorities for smoke matters. I did not find this too easy and I must ask you to pardon me if my early references are somewhat weighted in the direction of Manchester and Salford, as being easier to come by. In Manchester then we have to begin with a study of the doings of the manorial court or " Court Leet." In the 16th century their powers extended over the whole of the life of the town; by 1834, when Manchester passed its first bye-law (re industrial smoke) these powers had become limited to short weights, smoky chimneys, and offensive smells. In 1801 we note that a Nuisance Committee which had been appointed reported at the end of their report that —" the increase of steam engines as well as the smoke issuing from chimneys used over stoves, foundries, dressers, dyehouses and bakehouses, have become a great nuisance to the town unless so constructed as to burn the ' smoak ' arising from them, which might be done at a moderate expense." In 1838 the report of the Scavenging Committee concluded " by these means it is hoped that as far as the peculiar soil of the district, the quantity of soot falling and the great traffic on the streets will admit, no just reason will remain for complaints on this subject." I find that the Nuisance Committee appointed by the Police Commissioners about 1840 had to appoint inspectors and suppress nuisances and to carry out police regulations " relating to the height of chimneys, for the purpose of preventing nuisances arising from smoke and . . . . to take any steps which may be necessary for compelling the owners and occupiers of steam engines and fire engines to construct the fireplaces and chimneys thereof respectively in such a manner as most effectually to consume and destroy the smoke arising therefrom."

In 1844 the Nuisance Committee of the Borough Council, which had from a year previously acted for the township of Manchester, now gave place to a nuisance committee for the whole borough. This committee received special instructions about the suppression of the smoke nuisance and was directed to enforce Section 75 of the

Borough Police Act against all parties throughout the borough "who after due notice shall not so far as is practicable consume the smoke arising from their own furnaces." It is interesting to note that the Court Leet still functioned to some extent and in 1844 still fined or "amerced" factory-owners who allowed large quantities of smoke and soot to issue from their factory chimneys. In 1846 the Chief Constable reported "that it was common knowledge that the town was much freer from smoke than formerly" and in 1847 the Nuisance Committee appointed a special inspector for the suppression of the smoke nuisance. In 1865 Samuel Hurst was appointed Smoke Nuisance Inspector at 27s. per week. In 1850 it was reported that the smoke inspector had in the previous year taken observations of 510 chimneys, served 67 firms with notices to improve their furnaces, and had cautioned the owners of 231 other mills; 19 had been summoned, of these 16 had been fined the other three being withdrawn on its being shown that alterations were actually in progress to lessen the smoke. The first Manchester Smoke Inspector appointed under the smoke abatement powers in the Manchester Police Act of 1844 must have had an exciting time. He found one cotton mill emitting smoke for 8 hours 52 minutes out of a nine hours observation. Others varied from 8 hours 2 minutes to 1 hour 50 minutes.

Still the smoke nuisance persisted and increased. In 1854 Dr. J. P. Kay reported for the Manchester Board of Health that the district known as "Little Ireland" was surrounded by some of the largest factories of the town "whose chimneys vomit forth dense clouds of smoke which hang heavily over this insalubrious region." In 1844 and 1845 Peel's Tory Government's Royal Commission reported that the provisions regarding smoke abatement found in certain local acts were to be generalized. About this time a body called the Towns Improvement Company issued a report later confirmed by Dr. Lyon Playfair in which *inter alia* Manchester was complimented for its anti-smoke proceedings "against powerful manufacturers" and here Dr. Playfair put Manchester first "as it had hitherto done its duty so well."

In 1868 Dr. John Leigh was appointed Manchester's first Medical Officer of Health, and soon the work of co-ordinating the committees was begun, and the Nuisance Committee, which had previously had the dealing with smoke problems as one of its duties became merged in the new Health Committee.

In 1850 Archibald Prentice had written "the volumes of smoke which continually issue from factory chimneys and form a complete cloud over Manchester certainly make it less desirable as a place of residence than it is as a place of business; and the enjoyment of the inhabitants would be greatly increased could they breathe a purer atmosphere, and have a brighter and more frequent sight of the sun."

In 1854 the eminent Town Clerk of Manchester, Sir Joseph Heron (Town Clerk 1838-87) reported to the General Board of Health that "dense smoke is hardly ever seen, and smoke of any description is very rarely and for very short periods observable." The Board replied, as one might have expected, "we regret to learn that Manchester with all the improvements effected is still a very smoky place." Mrs. Gaskell, however, found "green fields and meadows" in her walks in the Greenheys district of Manchester—difficult to imagine today!

So much for the Manchester of those days; now let us look how things were faring elsewhere.

Salford had four part-time policemen doing the smoke inspection work in 1844; and one full-timer from 1854. Leeds had an inspector in 1905. It was left to the London Coal Smoke Abatement Society to appoint the first smoke inspector for the metropolis and his name was Petty; it will

live as long as our Jimmie Law's predecessor at Sheffield—Nicholson, or as that of Alderman Adams at Newcastle. Birmingham had four smoke inspectors in 1903, whole or part-time.

Edinburgh

Interest in smoke abatement in Edinburgh does not appear to have begun until our member Allan W. Ritchie was appointed Chief Sanitary Inspector but at his instigation the local authority has got active in many ways—they have for instance a women's association and the age-old appellation of "Auld Reekie" is losing force.

Glasgow

Even if we were not in Glasgow there could be no hesitation in naming that redoubtable Glaswegian, Bailie William Brownhill Smith, who gave as his reason for joining the City Council "a desire to secure some effective control over the pollution of the city's air." He used to lecture on smoke abatement, using lantern slides of his own manufacture and he, in his enthusiasm, journeyed as far as Pittsburgh, U.S.A., to give lectures on the subject. This was in 1913; in 1920 he was a member of the Newton Committee on Smoke and Noxious Vapours Abatement, and he continued to do active work for smoke abatement until his final retirement in 1939. He was one of the founder members of the Scottish Division of the Society, then known as the Smoke Abatement League of Great Britain, and he was for many years acting vice-president—the Lord Provost for the time being acting as Hon. President. This is a most notable example of a voluntary worker pioneer finding he could do better work by joining the local authority and working from within. He died in 1948, aged 85.

In considering the early smoke history of both Glasgow and Manchester, we find references which suggest that smoke troubles in both these cases only began in the last century. McUre in 1736 found Glasgow "surrounded by cornfields, kitchen and flower gardens, and beautiful orchards, abounding with fruit of all kinds, which by reason of the open and large streets send forth a pleasant and odoriferous smell" while Eyre Todd's history states "at the end of the 18th century the clear atmosphere began to be darkened with a cloud of smoke."

Glasgow has for over 35 years been noted for its stokers' classes. They have both elementary and advanced, and if a man after being certified holds down a job for over two years, he is entitled to a block grant of £25. Glasgow has through one of its most munificent benefactors shown us what atmospheric pollution is losing us from the aesthetic point of view for Sir William Burrell desiring first to donate to this city a valuable collection of paintings, etc., felt himself compelled to make it a condition of the bequest that they should not be shown within ten miles of Glasgow and later left a quarter of a million sterling towards building a gallery as a home for the bequest, "not less than thirteen miles from Glasgow Royal Exchange."

Before I leave Glasgow or Scotland I must remind you that the term "black smoke" which, except in Nottingham and Leeds, is essential in the proof of a prosecution in England under section 104 of the Public Health Act, 1936 (but not under s. 101, where a nuisance must be proved), is unknown in Scotland's smoke byelaws. Here the adjective used is "dense" and two minutes of dense smoke in 60 will suffice to make a prosecution proven.

As I am speaking in Glasgow a word or two about the friendly rivalry between the two sister cities may not be out of place. I understand that Edinburgh concedes precedence to Glasgow so far as smoke production is concerned and the gauge records would seem to confirm this. But in my part of the world we have a saying, "Where there's muck there's money," or, as you here probably say, "brass," so here may be a cause for

rivalry! And the muck in the atmosphere, through the said money got from it, accrues to the benefit both of those whom the U.S. call morticians and the profession to which I belong. But Auld Reekie—the name must have arisen in ages past when Glasgow was green fields and long before industrialization,—*their* smoke must have been domestic. I seem to have read somewhere, in Scott or elsewhere, " Reekie's put her caps and bonnets on " of an occasion when, in those days, a prosecution for black—I beg Scots law's pardon, I mean *dense*—smoke would ensue. I am on more ticklish ground if I refer to another saying often quoted between two other rivals, " Manchester men and Liverpool Gentlemen," because I have also heard of saying that when a visitor arrives in Glasgow, Father says " Put on the kettle Mother " while in Edinburgh he says " Turn on the wireless Jean." One last point to allay any possible fears: There is an expression peat-reek which refers to smoke from burning peat presumably used in a distillery, but also I believe, a synonym for the product of the distillery. I hereby declare that it is no part of the policy of this Society to wage war on or seek abolition of that commodity.

Smokeless Zones

Smokeless Zones, which we owe to the inspiration of our late Chairman, Charles Gandy, a Manchester barrister, are more suited for local control than are most features of Smoke Abatement propaganda. The demand for a smokeless zone must, it seems to me, indicate a local authority awareness of the serious impact of the excessive smoke on the health of its citizens. Two reasons were given for a recent refusal to allow a smokeless zone scheme to proceed—(i) shortage of suitable smokeless fuels and (ii) shortage of steel for conversion of appliances. As regards (i) the locals knew better and as regards (ii) the ban on the use of steel for making appliances has now been removed. Manchester and Coventry smokeless zones have now been in being for roughly a year and a half each. Manchester got its powers first, but Coventry got into action first and we shall hear from Dr. Clayton, Coventry's medical officer, tomorrow morning, some account of their first year's working.

Sheffield has always been in the forefront of Smoke Abatement measures. Its school for stokers has had a two years' course for many years at the end of which the candidates take the City and Guilds certificate. Those holding this thereby obtain preference in getting posts, but increase in pay should be the reward. Proficiency should be periodically tested, as in the St. John Ambulance Teams—especially the railway teams.

Statutory and Advisory Committees

But the thing which makes Sheffield unique in Smoke Abatement work is that it is the seat of the Sheffield, Rotherham and District Statutory Committee. These two Corporations jointly agreed to pool smoke duties from 1st July, 1927, and later, from 1st April, 1930, an agreement was made which included at first, four and now five district councils. The first four were Rotherham Rural, Stocksbridge Urban, Rawmarsh Urban and Greasborough Urban. All the members of this body are members of local authorities or officers thereof. The Inspector of this Statutory body has four assistants and he can enter all areas which have joined but cannot go into areas which have stood out from the scheme and which are getting benefits they do not pay for, as smoke has no boundaries. A grid system is really needed. This is the first Statutory Committee to be set up under the 1926 Act, and so far the only one, though had it not been for the last war several regional committees would no doubt have become statutory committees before now. Domestic chimneys are not included in this scheme, the expenses of which are met by the constituent authorities according to their respective rateable values.

The Manchester and District Regional Smoke Abatement Com-

mittee now has upwards of 80 subscribing local authorities. If statutory committees such as the Sheffield and Rotherham one, the pioneer, were made compulsory we might get somewhere. Either increase the work of the Alkali inspectorate to include smoke and all factory chimneys, as suggested in 1898 in the Leeds Smoke Abatement Society's unsuccessful memorial to the Local Government Board, or introduce a " grid " system. Don't allow any local authority to " stand out." " Gaps " mean failure. To stand out is nothing but pure selfishness and narrow-mindedness. Full consultation with the Ministry of Fuel and Power and its officials and technical staff is essential.

Apart from Sheffield, and also in Yorkshire, Bradford, Leeds and Huddersfield had early stokers' classes and did pioneer work in this way. The local acts often differ in their provision, e.g., the Leeds local act does not restrict prosecutions to *black* smoke, and it provided for the appointment of a smoke inspector, who was appointed in 1905; Nottingham (1874) preceded Leeds in not being limited to black smoke, and this act does not admit the defence that " the best practicable means " have been used. Some acts imposed higher penalties than the National Public Health Act of 1936: these were Nottingham, Leeds and Sheffield. Bradford dealt with grit also (1913, 1916). Birmingham had four inspectors in 1903 (whole or part time). They made their first byelaw in 1927 under the 1926 Act, which was superseded by a later one in 1937. The Midlands Joint Advisory Council was formed in 1928, also under the 1926 Act; this is a voluntary body whose membership derives solely from local authorities and in 1939 it enlarged its scope so that it covered fumes, dust, etc., connected with industry and not necessarily with heating installations only. The West Riding, London and the Home Counties and Tees-side also have advisory committees.

The principle of " prior approval " already in force for chemical and other works under the Alkali Act was extended to combustion processes by two local acts of 1946—the City of London (Various Powers) Act and the Manchester Corporation Act. This spread of prior approval clauses may truly be said to be largely due to the work of the N.S.A.S.

In considering the future relationship of the Local Authority to the Government regarding Smoke Abatement we are compelled to argue from past experience and remember that the lead has always come from the local authorities and never from Whitehall, who have consistently refused local authorities' requests. It is beginning to look as if this was going to be the position regarding smokeless zones because the reasons given for refusal a year or two ago have not applied for many months past.

The position regarding smoke inspectors is difficult. The smaller local authorities have not the power or the money to do the job effectively. They, certainly, could not pay a sufficiently well-qualified inspector, who, in the future, must be an engineer. But, as the law stands today, they can refuse to join a regional advisory committee, or, by standing out, a statutory regional committee such as Sheffield and Rotherham, and so refuse the Inspector access to their territory. It is also clear that while certain larger authorities are really efficient in their drive against smoke, yet others both large and small, do not take their duty seriously. Some are influenced by the false argument that " *we* have no smoke," forgetting that smoke knows no bounds and that other people's smoke invades them whether they know it or not, and may do so more in the future; others are in the power of large local industrial leaders who are antagonistic, either with the idea of keeping the rates down, or, some of them, strange as it may seem, still imbued with the idea that " we want *more* smoke," on the theory that more smoke means full employment at the factories. So far, and going back very many years now, the Government has practically always

refused the suggestions of local authorities or has taken " no action," save the appointment of committees who take years to report.

Propaganda

In going through the records of local authorities in relation to smoke one is struck by the turn which their anti-smoke activities have again and again taken in the direction of organizing meetings, and of course, less frequently, exhibitions, and how these, especially the exhibitions, have been followed by a definite increase in local anti-smoke activity. The great Mansion House meeting organized by the Lord Mayor of London in 1883 had followed the South Kensington Exhibition of 1881, which 116,000 people attended, and the Manchester Exhibition of 1882. In all smoke abatement work the Public Control Committee of the London County Council has always played its full part. Their 1904 report, which incudes a history of the problem, especially as regards London has been most valuable. They have recently become members of the N.S.A.S. At all exhibitions the attendances have been uniformly good, the press have been invariably helpful and in the case of Manchester a subscription list of £800 was put up before it opened, to defray expenses, which included the publication of a daily journal. This exhibition was opened by the Mayor, and owed much to the enthusiasm of Principal J. W. Graham and of Mr. T. C. Horsfall. Sheffield held an exhibition in 1909 and in 1912 an international smoke abatement exhibition was held at Islington. At this period neither women nor juveniles were apparently especially interested, and in the future I have great hopes of both these groups.

The Potteries—Replacement of Bottle by Tunnel Kilns

Smoke Abatement in the Potteries is making great progress as a result of the gradual conversion of the old intermittently fired bottle kiln to the continuously fired gas or electric tunnel kiln which has been going on for some years now. In 1940 there were 2,191 bottle kilns still in use; in 1948 there were 1,403; in 1953 there are about 1,000. The consumption of gas for pottery firing was 7,444,000 cubic feet in 1932; in 1952 it was 4,778,889,200. The number of gas-fired kilns in 1932 was one; in 1952 it was at least 209. As regards electrically fired kilns the units of electricity used for ceramic firing was 4.2 million in 1932; last year it was 62 million. In the year ended 1st April, 1938, 21 kilns were electrically fired; in 1948, 58; in the year ended 1st April, 1953, there were 131, i.e., 111 continuous and 20 intermittent. It is calculated that three coal-fired bottle kilns can be replaced by one continuous electric kiln. The most recent figure for the cost of electricity for firing purposes is 0.931d. per unit. As early as October, 1940, Wedgwoods were using their electrically-fired tunnel kiln at their new factory at Barlaston. (See article in *Smokeless Air*, Spring, 1941). It has been calculated that there has been a fourfold increase in gas-fired kilns since the war, and that the amount of coal saved is two-thirds. Another calculation is that of the 1,000,000 tons of coal used in the potteries pre-war, only 400,000 tons or two-fifths are now needed. While the fuel costs go down so does the amount of speckled rejects, *and* there is no smoke emitted. But the full advantages of tunnel firing can only be achieved if the conversion takes place as part of a complete modernization of the works, requiring considerable capital and only possible of fulfilment when trade is slack. But saving includes, apart from fuel costs, the cost of labour in placing, of saggars and of kiln furniture; whilst dumps of coal fuel and of ashes, with consequent labour, are no longer seen and general working conditions are much improved. One looks forward, at no very distant date, to the last bottle kiln being " plaqued " and scheduled as an Ancient Monument.

But the smoke nuisance in the Potteries is still serious. There are still notable omissions from the new

method of firing and the problem of domestic chimney smoke is still there. At two of the three recording stations the total solids deposited have been reduced by about one-eighth, whilst the third station shows no improvement up to the date when, owing to the outbreak of war, the readings ceased. It may perhaps be assumed that the same lessening has occurred there. The recent yearly average readings of the one lead peroxide instrument (Leek Road, Stoke), show a reduction in sulphur dioxide as compared with pre-war years, expressed as m.g. SO_2 per day per 100 sq. cms. exposed surface (cowl covered instruments),

e.g., 1935-6—2.71
1951-2—1.70

Appeal to the fortunate ones

I now, before closing, wish to make a definite appeal to the more fortunate ones. I have twice before in this address indicated by statement or by inference that in certain quarters there is a lack of team spirit or "esprit de corps" and I wish to emphasize this aspect of things. We know that "smoke knows no boundaries" and those of us who have visited the Isle of Man know that a good example of that slogan is to be found there, when in certain winds, the smoke from the industrial mainland reaches as far as that island. The local authorities in the more fortunate areas should surely become interested, join the Society, not remain outside of the regional committees, etc., for—to put it no higher—they will thereby be safeguarding their own future, as industrial areas change localities, they will be recognizing the truth that many of the smoke burdens are truly national, and that some of them they are even now bearing unwittingly. Even County Councils which tend to remain aloof should be interested, for though not smoke abatement authorities under the Public Health Act they are directly concerned with the general health and with housing and town planning. The Ministry of Housing and Local Government has now indicated that they may apply for membership with the Ministry's approval.

Methods by which Local Authorities may Advance Anti-Smoke Propaganda

1. The institution of more regi nal committees, and the making statutory those already existing.

2. The formation of women's associations on a par with the Electrical Association for Women and the Women's Gas Federation, which have done and are doing such good work.

2A. A similar, but juvenile, organization.

3. The creation of more smokeless zones and the extension of those already existing.

4. By repeated approaches to Government departments regarding (3).

5. By increasing the number of smoke inspectors and improving their qualifications.

6. By forming more "stokers' schools" as so well and long run at Glasgow, Manchester and elsewhere.

7. By exhibitions, meetings and broadcasts.

8. By appealing to local authorities not directly and immediately concerned to play their part as a safeguard against the future—and to note that their air is no doubt polluted from elsewhere by wind-driven sulphur fumes, etc.

9. Through the Central Council for Health Education.

Financial Aid of Local Authorities to Smoke Abatement

This must be worked out under various heads, such as:

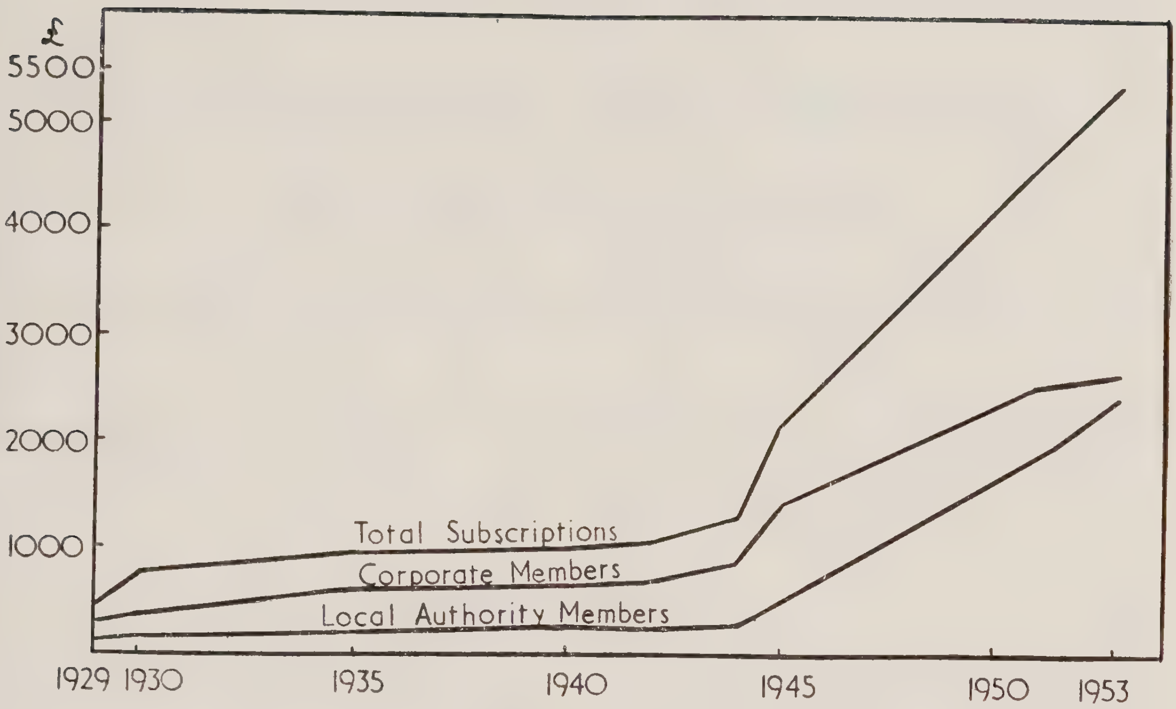
1. Cost of inspectors, etc., regional committees, expenses to N.S.A.S. meetings and conferences and those of the Standing Conference on Atmospheric Pollution.

2. Local propaganda, exhibitions, etc.

3. Cost of Acts, byelaws, powers for smokeless zones, etc.

4. Subscriptions to the National Smoke Abatement Society.

Some of these headings it is almost impossible to estimate the cost of, but the following figures show how subscriptions from local authorities to the



The Society's Annual Income (*Individual Membership Subscriptions not shown*)

National Smoke Abatement Society have increased fourteen times since 1930:

Year ended 30th June,		1930—£175
,,	,,	1940—£269
,,	,,	1951—£1,832
,,	,,	1953—£2,444

In 1930 the average local authority subscription was £2 13s.; now it is £6.

Over the same period of years the subscriptions of individual members, apart from the war years, have increased slightly, whilst those of corporate members rose even more strikingly than those of local authorities. Here are the figures:

Year ended 30th June,		1930—£363
,,	,,	1940—£610
,,	,,	1951—£2,515
,,	,,	1953—£2,649

The Society has now more than 440 local authority members; in 1929, at the time of the first conference at Buxton, when the two older bodies amalgamated, it had 66. The curve formed by the local authority and corporate member groups is shown in the accompanying chart. It is also interesting to note that our first Glasgow conference in 1934 broke the then record for attendance—195. The score today is more than double that —about 450

Epilogue

Now I have come to the end of my active duties as President. It is a great pleasure to thank Mr. Marsh and Mr. Silver and the rest of the Staff—now one more in number than a year ago, as a result of increased subscriptions—for all the help they have given me throughout my term of office. I also owe my thanks to Sir Ernest Smith, my successor, to whom I add my best wishes, and to Mr. Duguid, and in connection with this address to Dr. Stuart Laidlaw and Mrs. Laidlaw and Mr. Ashford, of this city; Mr. Hurst and the Gas and Electricity Board Managers at Stoke-on-Trent; Messrs. J. F. Anderson, H. Moore and J. Lawson, and to Doctors G. Fletcher, Martine, Metcalfe Brown and J. L. Burn; also to Alderman Yorke and Dr. Llewelyn Roberts of Sheffield.

I have enjoyed my period of office. It is always both pleasurable and profitable to work with a keen team, who work as a team.

ATMOSPHERIC POLLUTION IN RELATION TO PREVENTIVE MEDICINE

by

Sir John Charles, M.D., F.R.C.P., D.P.H., Hon.D.Hy.

Chief Medical Officer, Ministry of Health

The Book of Ecclesiasticus contains both the exhortation to praise famous men, and an adulation of the physician. In the Des Voeux Memorial Lectures there is a natural confluence of these themes, and a further purpose to be fulfilled.

"Honour a physician with the honour due to him" says Ecclesiasticus, and adds "for the uses which ye may have of him." These lectures do not commemorate Des Voeux the man, or Des Voeux the trusted practitioner of medicine, but Des Voeux, the physician pioneer who used his knowledge and energy in the pursuit of a neglected cause. His times had need of him for that purpose and use.

And yet his success as a pioneer derived not from one narrow, forceful streak of character, but from the happy mixture of ancestry, culture, education and élan which was Harold Antoine Des Voeux. Born in 1861, of an old French noble family which had settled in the Queen's County of Ireland, and changed its name from de Bacquencourt in the process, Harold Antoine was educated at Wellington and St. George's Hospital, London. He was admitted as a Member of the Royal College of Surgeons of England in 1883, and settled in practice in Buckingham Gate where he rapidly became the physician-counsellor of many distinguished people. His activity of mind, culture, cosmopolitan outlook, integrity and financial acumen made him the inevitable choice for office in many medical societies. But some inborn nostalgia for the clear light airs of his native Ireland or his ancestral France led him to resent the fuliginous pall of London, fired him with a desire to relieve the metropolis and other urban communities of their atmospheric gloom, and led to the founding of the Coal Smoke Abatement Society.

At a time when such an activity was considered not merely the hall-mark of the crank, but the sign of an enemy of the liberty of the individual, it was well that a person of such conviction, driving power and charm as Harold Des Voeux should have been identified with the cause of Atmospheric Purity. Of his labours he himself saw the first-fruits; we have the promise of an even more abundant harvest.

My predecessors charged with this memorial task have used their opportunities in somewhat different ways. From Dr. Townend the Society received a comprehensive and compendious survey of the basis of modern knowledge of Smoke Abatement.

To Dr. Bronowski we were indebted for an imaginative anticipation of the problem of smoke against the major

problem of our industrial future.

Neither the technical knowledge of the one nor the gift of enlightening foresight of the other are at my disposal, and I propose, therefore, in a more pedestrian fashion to ask you to consider the relationship of Atmospheric Pollution to the Public Health, to examine critically some aspects of that relationship which have been assumed rather than proved, and to suggest how that branch of medicine which we call Preventive Medicine can furnish easement or remedies.

Let us commence with one or two definitions, if only to fix some reasonable term to this lecture.

Strangely enough there are elements of mystery about the word group "Atmospheric Pollution." Atmosphere and its adjective are words which must be included amongst the neologisms—that category which Hilaire Belloc described as being "afraid of no man—fresh, young, hearty and for the most part very long-limbed." It is a pseudo-Greek word, graduating through the Latin, and was first used by Wilkins in 1638 to mark out "an orb of gross vapours . . . . encompassing the body of the moon."

Pollution too, has an odd history, because wrapped up inside it is the Greek word "to wash." Suffering a sea change of degradation pollution came to mean to the Roman, first the moistening of something with an unclean fluid, and later that uncleanliness or defilement itself. The learned Sir Kenelm Digby, as quoted by Evelyn, outlined the doctrine of "Atomical Effluvias and Emanations," and came very near to a description of Atmospheric Pollution which would suit us today. He observes "that from the materials of our London Fires there results a great quantity of volatile salts, which being very sharp and dissipated by The Smoake doth infect the Aer, and so incorporate with it, that though the very Bodies of those corrosive particles escape our perception, yet we soon find their effects by the destruction which they induce upon all things that they do but touch; spoyling and destroying their beautiful colours with their fuliginous qualities."

In more modern times Atmospheric Pollution has come to mean the introduction into pure air of undesirable gases and of noxious particulate material in the form of micro-organisms, aerosols, or other and grosser particles. More recently still, it has been enlarged to include the presence of radioactive ionisations.

Essays have been written—one might almost say circumscribed—about Preventive Medicine. The dust of conflict still hangs over the respective bodies of Preventive and Curative Medicine—brothers, twins, though not identical twins of the same stock. The late Professor René Sand has by genealogical analysis added three more members to the family of medicine—so that its scions are now Hygiene, Preventive Medicine, Curative Medicine, Restorative and Conservative Medicine. But the process of quintuplication does not end there. Professor Hugh Leavell of Boston has welded Hygiene and Preventive Medicine, and sub-divided the merged entity into five parts.

It is therefore essential to identify the Preventive Medicine we have in mind.

In the connotation in which we shall be thinking of Preventive Medicine it will be concerned with those disciplines and procedures which at the levels of the individual human being and of the community seek to procure a favourable environment and foster physical and mental health. Furthermore it will attempt to foresee, to prevent—in the Prayer-Book sense of fore-running—to modify and nullify the evil effects of disease provoking agents and mechanisms.

Historically the link between the Atmosphere and Disease has been suggested on many occasions, but the final proof has never been sought because of inadequate physical or intellectual equipment, or it may be that the complacency of half-knowledge has stifled further enquiry.

Hippocrates—to invoke one of the

earliest authorities, wrote at least two books—"Airs, Waters and Places" and the treatise on "Breaths," which as their names suggest deal with the association of air—dry, humid, hot, cold, and the insalubrity or wholesomeness of towns, islands, mountains, marsh-lands and human beings. But though Hippocrates' observations are accurate and pertinent, and gave him a foundation for his own speculations and conclusions, they remain for us but the records of isolated seasons, incidents and occasions. No statistical method fits them together, and provides a basis for future comparisons.

Let us look for a moment at Titus Lucretius Carus, the Roman poet of the first century before Christ. I suggest we do so because John Evelyn turned to him nearly seventeen hundred years later, when, to illumine the title page of his Fumifugium he chopped a quotation from the Sixth Book of Lucretius' mighty epic "On the nature of the Universe." That quotation, as given by Evelyn starts by saying "How easily the drowsy fume and scent of Charcoal passes into the brain," though it finishes (and Evelyn omits the closing phrase) —"Unless we have taken water beforehand." But what follows immediately in the Latin text is a veritable essay on Atmospheric Pollution and Industrial Medicine. Lucretius continues (and the translation is that of R. E. Latham in the Penguin Classics):

> "In the earth itself you often see sulphur generated and malodorous asphalt congealing. When men are following veins of gold and silver, groping with their picks in the bowels of the earth, what fumes are emitted from the pits of Scapte Hyle! What malignant breath is exhaled by gold mines! How it acts on men's features and complexions.
>
> "Have you not seen or heard how speedily men die and how their vital forces fail when they are driven by dire necessity to endure such work. All these vapours are given off by the earth and blown out into the open, into the unconfined spaces of the air.
>
> "So also these Avernian places must send up an effluence deadly to birds on the wing. As this rises from the earth, it poisons a certain tract of air. No sooner has a bird winged its way into this tract than it is caught and halted by the invisible venom. Down it tumbles in a sheer fall on the very course in which the vapour rises."

When we come to study John Evelyn's "Fumifugium," or "The Inconvenience of the Aer and Smoake of London Dissipated" it is inevitable that we should recognize and salute its merits. For any age or time it is a magnificent challenge; for its own it must have been a miraculous achievement and speculation, born a little prematurely, and, unhappily, without immediate success. It is an epistle of invective directed both at "the hellish and dismal cloud of seacoale—perpetually over London and so universally mixed with its otherwise wholesome air that its inhabitants breathe nothing but an impure and thick mist" and at all unbelievers and doubters. Written as it is in an opulent, mellow prose, heavily shot with adjectival fulminations and thunderings it has set a standard which lesser writers seek to attain at their peril. The vistas which it conjures up have been a delight to the historically minded for nearly three hundred years—the tunnels near Northumberland House and not far from Scotland Yard whence issued smoke presumptuous enough to invade their Majesties' Palace in Whitehall; the sad military investment of my native city, Newcastle, which brought plentiful and infinite quantities of fruit to the divers orchards and gardens in the Strand, the College of Physicians in arms against Evelyn's revolutionary suggestions and esteeming smoke to be a prevention against infections, the vessel fraught with peeled onions which should pass along the Thames collecting the polluted air, and sail away with it—onion buffered—to the sea.

All those are for a graceful enter-

tainment, and a shrewd, far-sighted vision of how London might be purified. But when we attempt to assess the validity of some of Evelyn's assertions in the medical field, we find him to be but little, if at all, advanced upon Hippocrates and Lucretius. Let us take one of his statements " That Catharrs, Phthisicks, Coughs and Consumptions rage more in this one city than in the whole earth beside." As rhetoric we would accept it, but as a statistical proposition it would never gain our support.

Then again he says " almost one half of them who perish in London, dye of Phthisical and Pulmonic distempers." An application to the Bills of Mortality which were weekly at his disposal would have shown Evelyn that common report was again exaggerating. In the four years immediately preceding 1661 when the Fumifugium appeared, the deaths from Consumption, Tissick, Cough and Plurisy as tabulated in the Bills of Mortality never amounted to more than 24.4 per cent of the total deaths, and averaged 22.6 per cent. for the period.

The three clarion voices of the Victorian era on matters sanitary, those of Chadwick, Farr and Simon, were rarely lifted in praise of atmospheric purity, or in forthright condemnation of atmospheric pollution. There was much else to claim their attention—Cholera, Smallpox, tunnel sewers and cesspools filth encrusted, the foulest of housing, inadequate and often contaminated water supplies, drunkenness, squalor, poverty—the vast accumulation of sanitary wrongs to use Simon's vivid phrase.

References were made, here and there to atmospheric pollution. Chadwick, the one non-medical amongst the trio touched on the subject with characteristic boldness in his tract on " The Clinical examination of a sick town." " Is the breath of the place sweet?" he asks. " Is it supplied with pure air or does mist hang over it morning and evening like a fog?"

But such direct references are uncommon, and usually the matter arises in strange ways, and often incidentally.

The concept of the " miasma "—the evil emanation which acted as the vehicle for the conveyance of infectious disease—was woven heavily into the idea of Atmospheric Pollution. Cholera was such a miasma-borne invader. Here is Chadwick on one of the aspects of the Cholera Epidemic of 1848-1849:

> " During the prevalence of the epidemic Lord Palmerston sent for me and told me that the Queen had been invited to return from Scotland in the direction of one of the infected towns, and also whether I thought it safe for Her Majesty to do so. I advised certainly not, and I did so from my belief that the epidemic was climatorial.
>
> " Instances were noted in India, Russia and Germany as characteristic of the epidemic that birds such as rooks disappeared on its advance and returned on its departure."

Later in life Chadwick was more impressed with the potentialities of clean air. With Dr. Neil Arnott, whose name is almost synonymous with ventilation, he proposed to float a Pure Air Company, which would operate under the slogan of " Ventilation from Cloudland." Air was to be drawn down by machinery from the upper couches or strata of the atmosphere and distributed through great cities, like the Metropolis. Special collecting towers were to be erected, and for some few shillings a year the city subscriber would have even a better air than he enjoyed in his suburban residence. I cannot trace that Farr ever indulged in comparable flights of perflative imagination—pipe or duct dreams. His was a much closer study of the facts of life and death as disclosed in the statistics. Periodically he would review the relative salubrities of the various cities and regions of England and Wales, and record his commentaries and pose his questions.

There are passages in Farr's reports which correlate cold weather and heightened mortality. Others again contemplate the death-rates from

pneumonia as they rose during the middle years of the 19th century, and hint that in this increase cold and the industrial nuisances of dust and smoke could be coupled together as causal factors.

Farr was particularly interested in London. " What is it," he asks, " that is so fatal to the working men of the Metropolis? Is it the smoke they breathe? It is well established that dusty particles interfere with respiration. They shut up and irritate the small bronchial tubes. Women breathe the smoky air as well as men, and yet they do not suffer to the same extent. Is it the dust of the workshops and streets, or the crowding? That has no doubt its influence. But will it account for the whole of the excessive mortality?"

Later in the same report he appends two pertinent comments which in fact answer his questions—" Much may be done by economy of fuel now sent into the atmosphere as smoke "— and " Soap is a great civilizer."

These latter quotations are from the prefatory letter which Farr wrote for the decennial supplement to the 35th Annual Report of the Registrar General which was published in 1875. It is to a great extent his testament, and for that reason his conclusions on Atmospheric Pollution are interesting. They epitomise his own views, and almost certainly are in advance of the popular opinions then current.

> " Air is well called vital . . . Always impure in marshes and cities, air is salubrious when it is fresh and moving. Air charged with inorganic impurities, sometimes with gas such as hydrochloric acid, sometimes with solid particles as grit and steel and smoke, irritates the air-tubes and inflames the small cells of the lungs. The gaseous impurities can be condensed, the dusty particles lessened . . . ., the steel particles arrested . . . ., the black smoke burnt."

John Simon has less to offer. The great series of Annual Reports to the Privy Council " On the state of the Public Health," of which Simon was author-editor contains only the most trivial references to Atmospheric Pollution as we comprehend it.

The 9th report for 1866 embodies a long 160 paged description of the sanitary improvements which had been carried out in 25 previously unhealthy towns and districts in England and Wales, and of the beneficial results which could be associated. One of Simon's successors as Chief Medical Officer, Dr. George Buchanan, was responsible for this laborious study, but where he is able to record an improvement in the atmospheric conditions, he relates it to the disappearance of malodorous cesspools, the cleansing of encrusted sewers, and the moving of the mighty middens, which in certain towns had achieved the status of ancient monuments. In the last chapter of " English Sanitary Institutions," the masterpiece which Simon finished in 1889, there is a single long paragraph on the smoke nuisance. It is both a measure of his interest and an example of his prose.

> " Again . . . see with what apparent indifference our nineteenth century England acquiesces in a daily-increasing sacrifice of daylight to dirt.
>
> " There are immense masses of our population . . . who endure without revolt or struggle the extremities of general Smoke Nuisance, not only condoning the fact (on which here the argument does not turn) that the nuisance is of painful injury to an appreciable population of persons, and in certain states of weather kills many of them; but further (which is here the point) accepting, as if in obedience to some natural law, that their common life shall in great part be excluded from the pure light of day . . . by an ignoble pall of unconsumed soot, and hardly murmuring in their self imposed eclipse . . .
>
> " A great people, determining what it will deem to be proper purity for air and water, has not to measure only from the scavenger's point of view but . . . with some

sense of the help which accrues to the human mind from beholding the pure aspects of nature, and with some readiness for displeasure when the beauty and bounty of nature are wantonly affronted by slovenliness and waste!"

I am beginning to be very conscious of the reproach of Maccabees. "It is a foolish thing to make a long prologue, and to be short in the story itself."

This extended prelude has had a double purpose. First, it was intended to shed some light upon the state of public opinion in the matter of Atmospheric Pollution over long periods of time. Too often and unhappily, as Simon discovered, public opinion has been bathed in the dull gloom of acquiescence. Its further objective was to suggest that the assumed effect of pollution on the Public Health has rarely been clinched. Even when crude and elementary methods of proof have been available too often they have not been used. The thesis of the noxiousness of pollution has been readily accepted, but the intellectual zeal and industry which were required for its final demonstration have not been applied. Far too frequently the blunt weapon of assertion has been preferred to the precision tool of proof. With primitive methods we have been forging an assegai, when we needed a razor blade to cut the knots of the unknown.

Our historical wanderings have brought us within sight of the present century, and within sound of the deliberations of this society and its forerunners. But during the past fifty years how much better have we fared in linking ineluctably together the facts of Atmospheric Pollution, and the figures of sickness and diminished physical and mental health which we believe are attributable to it?

In the severely practical fields of smoke abatement and the control of atmospheric pollution we have had our success, and will fare even better. Therefore nothing I have said or have yet to say reflects in any way upon the magnificent outcome of the efforts which have been made in the scientific, technical and administrative fields.

My quarrel, if it can be called a quarrel, is that we have not elucidated more completely the sequence of cause and effect in the physiological and pathological phenomena, which manifest themselves in human beings exposed to the acute, and, in particular, to the long-term assaults of noxious atmospheres.

The nature of the mechanisms of disease and disability set in motion by atmospheric pollution are still largely, though not entirely, hidden from us.

With only fragmentary knowledge we are achieving something; with fuller understanding, with identification of causal agents and the tissue and body-fluid reactions they elicit, we might be able to rationalize the medical problems and simplify the task of the engineers and the administrators. We could preach an effective gospel of Preventive Medicine.

Certain of the pathological effects of Atmospheric Pollution have been unequivocally demonstrated; for others the evidence is strongly suggestive; but a large number of suspected associations between pollution and disease have little but speculation to support them.

Let us come to rather closer grips with the question. How can a polluted atmosphere assault the human being, and the aggregation of human beings which is the community? In the final analysis it is a highly personal matter. Epidemic episodes may possibly occur in which every member of the community is known to suffer, but more usually the mass phenomena of atmospheric pollution represents the summation of the personal experiences of a number of members of the community, short of the whole.

Open to the immediate assaults of the nocuum are the surfaces of the eye and the eyelids, the external ear passage and the ear-drum and the exposed surfaces of the skin. A little further removed is the respiratory tract in its upper and lower reaches, and to a varying extent the air cells of

the lungs. More distantly removed but nevertheless accessible is the digestive tract, and there is some evidence that oral structures such as the teeth can be damaged by atmospheric pollution, more usually as one of the dust or gaseous hazards of industry.

But by and large the stomach, speaking broadly, and the ears need not trouble us, for in this connection they are of academic interest only.

The eyes and the skin are much more frequent recipients of atmospheric pollution. For instance, that general murkiness which is the Los Angeles smog is pre-eminently an eye irritant and lacrimator.

The intact skin is, happily for the survival of the race, an important and efficient barrier against invasive micro-organisms, gases, chemical substances and other noxious materials.

But under certain circumstances it can be penetrated, or at least irritated. There are more than sixty substances which can be absorbed through the skin, many of them harmless; there are allergens in the form of dusts and pollens which by their assaults can evoke eczematous reactions; there are infecting bacteria and viruses; there are the effects of the variations in atmospheric pressure and humidity. All these are potent factors in the causation of skin disease especially in industry. And skin disease is a manifestation of ill-health which can never be lightly regarded because of its wider impact upon the comfort, happiness and mental health of the individual.

In many instances, though not in all, the causal agents for these eye and skin conditions have been identified. The evidence which implicates them as morbific is at least suggestive; in many cases it is beyond dispute. But the importance of pollution as an enemy of health rests on the extent of the damage it does directly to the respiratory tract and consequentially to the circulatory system. We can approach the study of the respiratory and associated sequelae of atmospheric pollution in a variety of ways. We can, for example, examine scientifically each category of noxious substances, break it down and isolate the allegedly culpable members, indicate their proved or assumed pathological effects, and translate that into something which can be regarded as an appraisal of their respective significance as regards the Public Health. The way is then open for the next step which is the application of the appropriate remedies whether administrative, technical or medical.

This is a laborious method and it disregards the fact that a causal agent rarely operates alone as does a poison. There is usually a background of associated or contributory causes. The remedy is rarely the application of a specific antidote. More often it is the administrative one of a new way of industrial or communal life—the introduction of a series of preventive measures in the factory; the institution of a smokeless zone in the city.

Alternatively we can divide the field of phenomena into the quickly-appearing, transient, catastrophes of atmospheric pollution, and the manifestations of slow-acting groups of agents and causal factors which function over a long period of time, being all the while the constant companions, the breath-fellows of a large number of mildly reacting human beings. For these two contrasting categories McDonald, Drinker and Gordon have suggested the descriptive terms " epidemic " and " endemic." The Meuse Valley, Donora, and London provide the scene of the epidemic episodes; the endemics are less easily identifiable, but they include, at least in the respiratory field, the possibility of lung cancer and the physical effects of inert dusts, and in the general field the lack of sunlight, and the psychological trauma inflicted by gloom. It is debatable whether this classification has much to commend it except that it evokes the satisfying and stimulating feeling of analogy with plague and pestilences. From the practical point of view it is incomplete, for the causes have still to be identified.

There is a third measure, which

because of its practical value we shall adopt. It is to assemble the various agents in groups which correspond to the quality of the evidence implicating them as effective factors in the causation of respiratory and circulatory disease and disability. So we will have agents whose causal significance has been unequivocally demonstrated; others which have a suggested association, and those whose causality is speculative. The advantage of this arrangement is that it enables us to see how a proved attributability is the first step to simple and effective control. If this were a treatise on the subject one would here insert a comprehensive three-part schedule with sub-headings, cross references, which would include all known or suspected morbific agents, and recommend the appropriate action for their regulation.

But our method, I hope, will be somewhat less tedious. It will select a few examples in each of the three categories; indicate in a general way how they have conformed to or fallen short of the suggested criteria, to envisage the principles, but not the detailed operations, of the measures which have been employed against nocua, proved and suspected, and above all foster that spirit of philosophic doubt which demands energetic research and enquiry, so that against more and more agents an unassailable verdict of guilty can be found.

Industry has thrown up sporadic examples of acute poisonings of the atmosphere due to accidental spillings and leaks of substances such as chlorine. The first completely authenticated case of a chronic poisoning due to such a chemically active pollutant operating over a long period of time was the discovery that zinc beryllium silicate could cause not only a highly characteristic lung disease in workers in a plant, but also in a woman living in the neighbourhood, who had never worked in the factory. A similar phenomenon was discovered on a larger scale in another town. Here there was the recollection of similar earlier cases in non-workers in the beryllium plant, which prompted the holding of a mass X-ray survey. This revealed more cases with the typical radiological signs in individuals living within threequarters of a mile of the factory, enjoying the dust effluent, but not working, either then or previously, within its walls. The amount of pollution was exceedingly minute, but it was sufficient to make it more dangerous for some persons to live constantly within striking distance of the factory's dust effluents, than it was for others to work an eight-hour day in the midst of beryllium processes provided that their homes were outside the range of the polluted atmosphere. Obviously where such a hazard has been identified its elimination though not necessarily simple is a challenge to the engineers.

Not as conclusively demonstrated but of a comparable significance is the record of the Danish town where an epidemic of pneumonitis was attributed to the operation of a manganese extraction plant, and was brought under control by appropriate measures. Other examples of chronic respiratory disorders attributable to atmospheric pollution are the pneumokonioses or lung-dust diseases. Because they are acquired in industry we are apt to forget that these diseases are the key to the effects of particulate material upon the respiratory tract. Until comparatively recently the study of the physiological and pathological processes involved had been conducted in a rather haphazard manner, but since 1945 the Medical Research Council has made them the subject of intensive investigation at the Pneumokoniosis Research Unit at Llandough Hospital, Cardiff. For the first time the problems have been attacked fundamentally by a large body of laboratory workers and field investigators.

A great deal still remains to be done; many questions relating to the precise mechanisms by which the damage to the lung is brought about, the influence of chemical reactions in the tissues as compared with the purely physical effects of inert dusts, have yet to be finally answered. But in this field

respiratory physiology and pathology, marching alongside great advances in dust control, have already paid dividends in preventive medicine.

In this group of the proved offenders one can also include the allergens and the radioactive ionizations. We are prone to forget what a quantity of wretchedness the hay fevers can cause amongst their victims. Susceptibility to allergens is not simply a personal inherited characteristic; it can be acquired. In the great corn growing belt of the United States cities with vast grain storage capacity have experienced a form of air pollution due to parasitic fungi, the so-called smuts. Much ill-health in the form of asthma, hay fever and sinusitis has been associated with the allergenic activities of these moulds. Here again the challenge is to the engineers. As to the radioactive ionizations it is perhaps too early to speak, but apart from their use as weapons of offence, they represent potentially perhaps a very important addition to the list of industrial pollutants. Their effects as such upon community health will obviously have to receive the closest study and attention.

Let us look for a moment at some of the causes of disease and disability where the certainty of our knowledge is less firmly established and its completeness not so rounded off. Heading this list are the smogs of the Meuse, Donora and London. They appear in this intermediate category, not because of any doubt as to the deadliness of their manifestations. That fact is only too apparent in the death rolls. They are here only because we lack the final crowning knowledge as to how their lethal powers operated upon the individual human being.

We are now very knowledgeable about the atmosphere and meteorological conditions which promote the occurrence of "smog." But we are ignorant in great part as to the detail and sequence of the pathological processes which create the respiratory and circulatory emergency which is so often fatal. What exactly, for example, were the prevailing modes of death for the many hundreds who succumbed in London in the second and third weeks of December, 1952.

Obviously there was no common, specific identifiable process which applied the mortal stroke. An eminent pathologist surveying the post-mortem records of a number of cases was able to pick out only a small, almost an insignificant number, where the smog had taken a healthy child or man or woman and presumably killed them. Alongside these, however, there were many hundreds of elderly persons, some without recognized disabilities except age and lessened powers of resistance and resilience, and others again with disabilities that they have learned to live with comfortably in normal times. For these the smog was the last calamity. Their deaths were recorded under the headings of bronchitis, pneumonia (these two covering about half the total), respiratory tuberculosis, cancer of the lung, coronary disease and myocardial degeneration. Some died on the first day; the peak of mortality was reached on the third and fourth days; ten days after the commencement of the four day episode deaths were still occurring at twice the pre-smog rate. In the multiplicity of diagnoses and in the time distribution of the deaths there is further evidence of the complexity of the pathological processes at work. The stimuli which excite these pathological mechanisms are themselves complicated. Who can say what part should be assigned to the chemical and particulate pollutants, or to the changes in atmospheric pressure or to the effects of cold? Speculation of itself cannot help us. It may, in fact, lead us into the danger which Francis Bacon recognized. "Men," he said, "have infected their meditations, opinions and doctrines with some conceits they have most admired, or some sciences which they have most applied; and given all things else a tincture according to them." Much more profitable would be the acquisition of precise knowledge through research and experiment—a combined operation in which all the techniques and disciplines co-operate.

Professor Philip Drinker of Harvard has suggested the reproduction of smog conditions on an experimental scale in a disused railway tunnel, where all the contributory factors could be regulated in intensity and modified at will. Human volunteers would provide the material for physiological and other studies. That is one suggestion which might give doctors and engineers quick access to some of the knowledge they now lack, and fertilize their further thinking.

It is a moot point whether we should include in our category of suggestively associated causal agents the large group of known carcinogenic substances.

Soot, of course, was incriminated in the causation of skin cancer nearly 200 years ago, but its action on the lungs is much more questionable.

The quantity of the important carcinogenic substances, like Benzpyrene, that could be found even in town air is so small that its significance can hardly be regarded as established. There is, too, the fact difficult to assess that the origin of only a trivial percentage of all cancers can be traced back to these labelled carcinogens—at any rate as yet. Nevertheless these substances are present in the air when smoke and industrial effluents pollute it. There is also a body of suggestive evidence contributed by the statisticians and field epidemiologists.

Dr. Percy Stocks in this country, for example, has insisted that the mean hours of sunshine are significantly correlated with death rates from lung cancer, bronchitis and pneumonia, and much more so with lung cancer than with the other lung diseases. He submits that smokiness of the atmosphere may be important in itself in causing cancer of the lung, or, alternatively that sunlight is influential in preventing its incidence.

In another study Dr. Stocks has coupled the relatively high lung-cancer death rates of certain parts of London with their exposure to smoke pollution borne on the prevailing wind. Similarly in a number of districts in American towns Dr. C. A. Mills has traced a connection between soot-fall and death rates from the same group of diseases. In every case males were affected more than females, but the difference was less for cancer of the lung than it was for pneumonia and tuberculosis.

All in all the evidence is somewhat tenuous, and there is the further complication that several of our most careful observers—Professor Bradford Hill and Dr. Richard Doll in particular—are now convinced that the recent and accepted increase in cancer of the lung is directly related to the tobacco-smoking habits of its victims.

It may be that here again we have one of those convergences and co-operations of causes—a synergism—which are more and more recognized as knowledge extends.

For the moment, however, in any campaign to prevent lung cancer, restraint in smoking must take precedence of smoke abatement.

There remain for our consideration a number of chemical substances which in one form or another have been popularly associated with every disorder that the human respiratory tract can display. The common cold, sinusitis, tracheitis, chronic bronchitis, pulmonary fibrosis, pneumonia, tuberculosis and in another pathological field, anaemia, have been attributed to unspecified particulate material, sulphur dioxide and trioxide, carbon monoxide and the fluorides.

Admittedly some of these agents in sufficient concentration can evoke acute reactions, but it is with the chronic effects of prolonged exposure that community health is concerned. A somewhat ill-digested mass of statistical material would seem to associate high pneumonia and bronchitis death rates with heavy soot-falls or other indications of atmospheric pollution. Very few of these statistical associations can withstand vigorous criticism; many are little more than wishful thinking. Certain of the difficulties which appear in the presentation and discussion of the evidence derive from indefinite morbidity recording; others from an inability to

depict accurately the composition of the community at risk; others again are inherent in the overlapping effects of the contributory factors, such as the age and sex constitution of the population, occupation and housing.

Badly presented and intellectually unsatisfying though this evidence may be, it has yet a disturbing effect. We cannot escape the suspicion that " this most excellent canopy, the air " is for the countryman healthy and stimulating, but for the townsman " a foul and pestilent congregation of vapours."

Let us draw the threads of this discourse a little closer. There can be no debate about the desirability of curtailing and limiting atmospheric pollution. To ask for its complete suppression is to ask the impossible for Nature pollutes the atmosphere in her diurnal tasks. What is in question is the precise nature of the effects of pollution upon the health of the community. It is clear that these effects range from the catastrophic and deadly, to the long-continuing and insignificant. It is obvious also that there is much we do not know, or knowing do not understand. One of the deflating consequences of modern biological and medical science is that as soon as one scratches below the surface, a host of hitherto unthought of questions present themselves. At the pinnacle of apparent certainty the investigator realizes that questions outnumber answers, and descends to profess his ignorance and to pursue his humble enquiries.

Nevertheless, in the realm of medicine we have long learned that there are methods of treatment which achieve the desired result, even though the sequence and rationale of the therapeutic processes resist analysis.

The analogy with the therapy of atmospheric pollution, though never strict is none the less suggestive. There are administrative and technical measures which directed against atmospheric pollution on the grand scale can yield dividends for the public health, even though we remain profoundly ignorant of the *modus operandi* of the offensive agents upon the individual citizen.

One may be tempted to ask, " Why seek further ? " The broadly sweeping action has produced the desired result; " all else is refinement and sophistication."

So physicians might have argued when the sulpha drugs brought them unprecedented success in the treatment of pneumonia. Research in another direction, however, produced penicillin and ushered in the era of the antibiotics, with all the promise of greater precision and potency.

Research is hardly ever unnecessary or completely unrewarding. It may replace outworn ideas by more modern conceptions, it may add to knowledge, it may yield the specific answer to our question.

So too with atmospheric pollution in its relation to Preventive Medicine. The omnibus devices with which we seek and seek successfully to advance the public health and cleanse the atmosphere may be pragmatically satisfying. But they may also hide, as it were, under a bushel, a light which could lead us more quickly to the same desired end.

The path to such achievement lies through scientific research and enquiry. Karl Pearson in the first chapter of *The Grammar of Science* came in a few words to the very heart of the matter. " The classification of facts, the recognition of their sequence and relative significance "—that was his prescription for the function of science. It is, I know, the foundation of the beliefs of this society.

And as I close I would offer you the further wisdom of Francis Bacon as our familiar consolation:

> " If a man begin with certainties he shall end in doubts, but if he be content to begin with doubts he shall end in certainties."

THE LONDON FOG DISASTER

(1) Report by J. A. Scott, O.B.E., M.D., M.R.C.P.

Medical Officer of Health, London County Council

In its interim report (June, 1920, Cmd. 755) the Departmental Committee on Smoke and Noxious Vapours Abatement stated:

> "8. *Damage to health.*—We have received evidence with regard to the damage done to the health of the community by a smoke-laden atmosphere, and are satisfied that smoke has a serious effect on the general health.
>
> "9. Statistical evidence shows a close relation between the death-rate and the atmospheric conditions; the number of deaths from pulmonary and cardiac diseases is shown to increase in direct proportion to an increase in the intensity and duration of smoke fogs. The cause underlying the high mortality in towns, which is known to follow in the wake of a fog, must operate continuously, though to a lesser degree, on the health of an urban community."

From 5th to 8th December, 1952, inclusive, London experienced an intense fog which sadly illustrated the validity of the conclusions reached officially thirty-three years earlier. This period was marked, meteorologically, by almost complete absence of air movement and by low temperature, with the consequent arrest of the normal upward air circulation by convection currents. Hence smoke, sulphur oxides and other air contaminants increased to concentrations much above those for the normal winter season.

These figures, together with some drawn from mean daily temperature recordings at Kew Observatory, are shown in Appendix I but it may be useful to note here, for purposes of comparison, that average daily summer figures (June) for smoke are about 0.12 milligrammes per cubic metre of air and of sulphur dioxide 0.07 parts per million. The sharp rise in pollution which accompanied the fog led to maximum figures on Sunday-Monday, 8th December, of 4.46 milligrammes per cubic metre of smoke and 1.339 parts per million of sulphur dioxide. The mean daily temperature during the period 5th-8th December, was also some 12°F. below the eighty year average.

The deaths registered week by week from 16th November, 1952, to 10th January, 1953, in the Administrative County of London were as follows:

Week ending		*Total number of deaths registered during the week*
22nd November, 1952	..	753
29th November, 1952	..	853
6th December, 1952	..	945
13th December, 1952	..	2,484
20th December, 1952	..	1,523
27th December, 1952	..	1,029
3rd January, 1953	..	1,372
10th January, 1953	..	1,216

Up to the week ending 6th December these deaths were running at the normal winter average, which on occasion rises as high as 1,100. The following week reveals a dramatic increase which can only be attributed to the effects of the fog—indeed, none of the deaths shown above can be

attributed to the influenza epidemic which manifested itself in London later in January, 1953.

Comparisons in a catastrophe of this magnitude are inevitable and indeed salutary. The following table illustrates the peak fatality week of certain epidemiological events in London's earlier history as compared with that of the 1952 fog.

Deaths per million inhabitants in London during certain specified weeks

Week ending	4*th August*, 1866 (*Cholera*)	20*th Dec.*, 1873 (*Fog*)	9*th Nov.*, 1918 (*Influenza*)	13*th Dec.*, 1952 (*Fog*)
Deaths registered	876	713	1,085	745
Normal number for period and season	450	470	300	300
Excess of deaths over normal	426	243	785	445

The December fog can reasonably be said, therefore, to be the direct cause of 1,500 deaths in the Administrative County, and Logan[1] in a notable paper showed that in the $8\frac{1}{2}$ million population of Greater London it caused 4,000 deaths. " Smog " in the Meuse Valley in 1930 caused 64 deaths and in Donora (Pennsylvania) in 1948, 20 deaths.

The deaths in the Administrative County are analysed in greater detail in Appendices II and III. The figures show that every age group was affected though not unexpectedly the very young and the old were the most hard-hit. Among children aged four weeks to one year and among persons over 55, three times as many deaths were registered in the week ending 13th December as the average of the previous three weeks; in the other age groups the number was doubled. Deaths from bronchitis were ten times as many, from " influenza " seven times, from pneumonia five times, from tuberculosis four-and-a-half times, and from other respiratory diseases nearly six times. The fog was a critical event for those suffering from cancer of the lung, nearly twice the average number dying. Damaged hearts could not cope with the increased respiratory embarrassment and nearly three times the average number of deaths occurred from disorders of the heart and circulatory system. Gastro-enteritis deaths among children under one year old increased considerably—it seems likely in the circumstances that this event was secondary to an infection of the upper respiratory tract—otherwise, there was no significant increase in deaths from any other defined cause.

This episode coincided with the Smithfield cattle show, as, by a coincidence, the 1873 fog did also. In both instances otherwise healthy cattle died or had to be slaughtered (the *Times* of 12th December, 1873, reported that about a third of the animals had to be removed). Both in human beings and in animals the noxious effects were strikingly rapid; Logan[2] has pointed out the rapidity with which lethal events accompanied not only this London fog but also those of 1873, 1880, 1892, and 1948.

What elements in an urban fog cause such striking and speedy fatalities? Despite the many studies, of which that of the Donora episode[3] is an excellent example, it does not at present seem possible to implicate any single factor among the many products of incomplete combustion. Particulate matter, sulphur compounds, tarry constituents, and fluorides have all been implicated. Because of their

demonstrable effect on the fabric of buildings, the annual cost of which has often been estimated, sulphur products (2.3 million tons poured into the atmosphere of Great Britain each year) have come under most suspicion. But those who experienced the oily greasy film which covered furniture, property and persons in the December fog, and which replaced itself inside houses within an hour of being cleaned away, will not be surprised at recent speculations that the various factors may be cumulative in their effect. A recent cutting from *The Chemical and Engineering News* of 29th June, 1953, kindly sent to me by Dr. Mary Amdur of Harvard, has a brief account of recent experimental work which seems highly relevant:

> " From smog and aerosol research comes what has been called a ' fantastically dramatic death ' in four seconds. Ordinarily nontoxic gases like SO_2 and SO_3 which dissolve in the nasal passages—when carried to the lungs on an aerosol show high toxicity comparable to or greater than HCN in some cases. One such gas-aerosol combination immediately produces purple haemorrhage and clotting on reaching the lungs of test animals. Data indicate that an aerosol acts as a synergist carryir g soluble gas which, once in the lungs, is more toxic than originally believed . . . . 70 per cent. of gas-aerosol combinations tested are more toxic than they are individually, and in some cases non-toxics become toxic when they are carried by an aerosol."

Despite the immense amount of work already done, therefore, it becomes clear that a great problem faces the Committee on Air Pollution recently appointed by the Ministers of Housing and Local Government and of Fuel and Power and by the Secretary of State for Scotland. The proper discharge of their terms of reference may also involve experimental work with artificial fogs. But in the interval there is much that can be done by the ordinary citizen and by industry. The proper use of smokeless fuels in domestic grates, the abolition of abominations like " nutty slack," the discharge of industrial smoke effluents from chimneys at the proper height, even the cessation of industrial activity (as is now practised in many parts of America) when a fog seems likely—all this does not await the results of further research. The ordinary man in the street and the ordinary factory and office can do much to lighten Evelyn's 300-year-old condemnation of the " hellish and dismal cloud of sea-coal which maketh the City of London resemble the suburbs of Hell." The North Sea floods aroused the practical sympathy of the country as such disasters always do. The London fog cost many more lives and an untold amount of invalidity. It is time the country moved.

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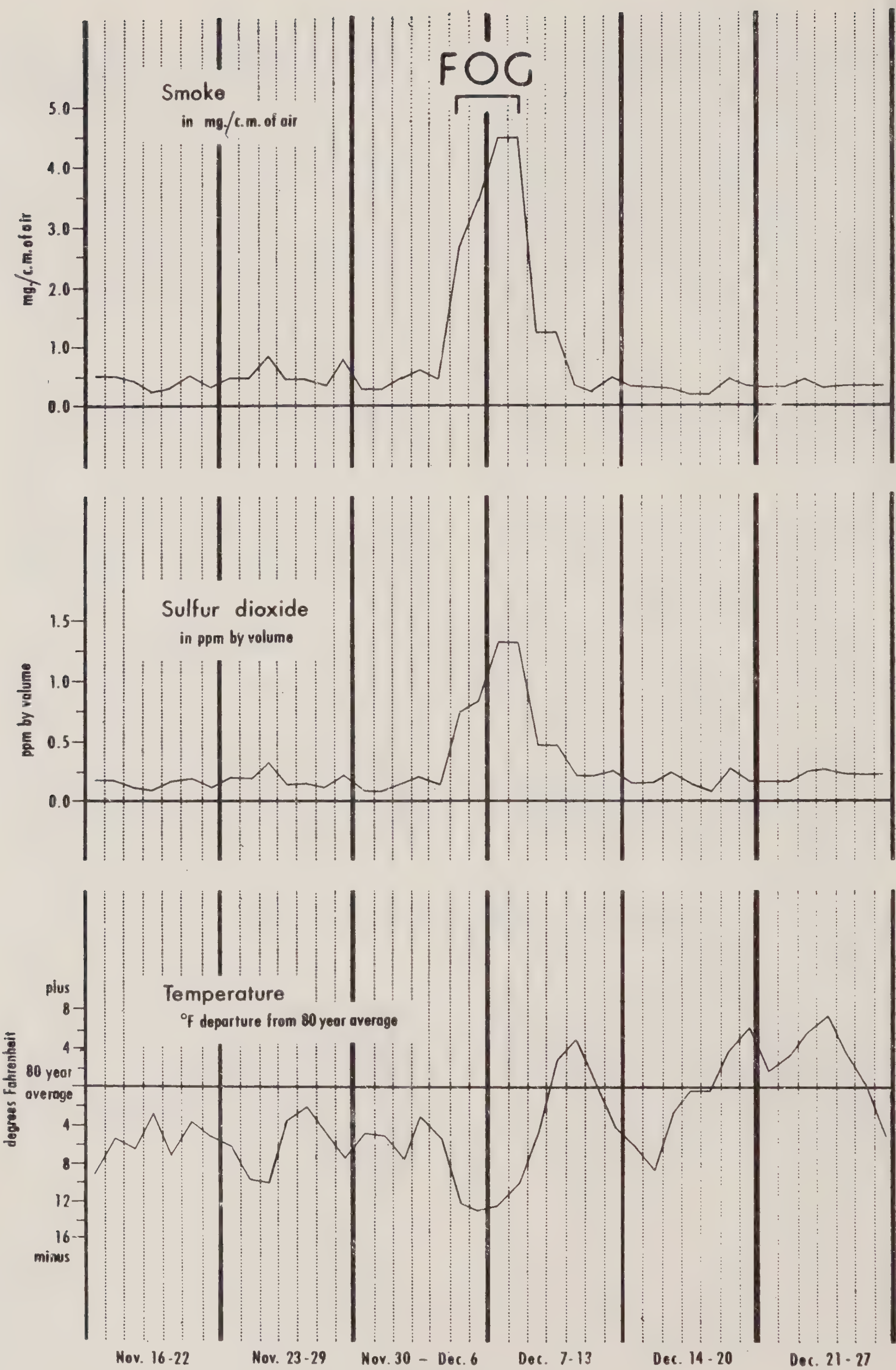

APPENDIX I

Daily smoke and sulphur dioxide averages at County Hall, London. Mean daily temperature at Kew Observatory shown as departure from mean daily temperature average of 80 years

November 16th — December 27th, 1952.

APPENDIX II

Registered Deaths in Administrative County of London, by Age Group, week ending 22nd November through week ending 27th December, 1952

Age	*Number of deaths for week ending*						*Average number of deaths per week for weeks ending 22nd and 29th November and 6th December*	*Percentage of average of first three weeks for week ending*		
	22nd Nov.	*29th Nov.*	*6th Dec.*	*13th Dec.*	*20th Dec.*	*27th Dec.*		*13th Dec.*	*20th Dec.*	*27th Dec.*
Weeks										
0–4	13	22	16	28	19	12	17.0	165	112	71
4–52	5	9	12	26	15	11	8.7	300	173	127
Years										
1–4	11	5	6	7	13	7	7.3	96	177	96
5–14	4	3	4	6	6	2	3.7	164	164	55
15–24	4	3	9	7	14	7	5.3	131	263	131
25–34	14	7	16	28	17	11	12.3	227	138	89
35–44	28	22	36	64	29	34	28.7	224	102	119
45–54	85	61	80	204	96	83	75.3	271	127	110
55–64	118	152	157	448	251	167	142.3	315	176	117
65–74	229	226	254	717	444	258	236.4	303	188	109
75 and over . .	242	343	355	949	619	437	313.3	303	198	139
All ages . .	753	853	945	2,484	1,523	1,029	850.3	292	179	121

APPENDIX III

Registered Deaths in Administrative County of London, by Certain Causes, week ending 22nd November through week ending 27th December 1952

Cause	*Number of deaths for week ending*						*Average number of deaths per week for weeks ending 22nd and 29th Nov., and 6th Dec.*	*Percentage of average of first 3 weeks for week ending*		
	22nd Nov.	*29th Nov.*	*6th Dec.*	*13th Dec.*	*20th Dec.*	*27th Dec.*		*13th Dec.*	*20th Dec.*	*27th Dec.*
Pulmonary Tuberculosis ..	18	19	14	77	37	21	17.0	453	218	124
Lung Cancer	38	27	45	69	32	36	36.7	188	87	98
Heart Disease	225	272	273	707	389	272	256.7	275	152	106
High Blood Pressure ..	12	17	19	47	36	21	16.0	294	225	131
Other Diseases of Circulatory System	27	23	26	46	31	32	25.3	182	123	127
Influenza	1	7	2	24	9	6	3.3	720	270	180
Pneumonia	31	28	45	168	125	91	34.7	486	362	264
Bronchitis	46	73	76	704	396	184	65.0	1,083	609	283
Other Respiratory Diseases	10	8	9	52	21	13	9.0	578	233	144
Ill-defined Causes	19	26	25	79	35	37	23.3	339	150	159
All Other Causes	326	353	411	511	412	316	363.3	140	113	87
All Causes ..	753	853	945	2,484	1,523	1,029	850.3	292	179	121

(2) Report by A. Parker, C.B.E., D.Sc.

Director of Fuel Research, D.S.I.R.

1. Under usual meteorological conditions the temperature of the air decreases with increase in height above the surface of the earth, and there is a natural circulation of the air by movement which we describe as a breeze or wind. Occasionally, there are somewhat abnormal conditions when the temperature of the layers of air near ground level is lower than that of the layers above, and there is little or no wind so that the lower layers of air are almost stagnant. Under such conditions, if the air is humid, moisture condenses in the form of fine particles in the layers near the ground and there results a fog or mist. This fog or mist is the result of certain natural phenomena under conditions known as "inversion," because the temperature gradient in the air is the reverse of the usual gradient. At such times the "inversion" is generally more pronounced during the hours of darkness than during daylight. There is no known economic method of preventing or dispersing a natural fog or mist covering a large area. In a country district where the air is relatively pure, the mist is whitish in appearance.

2. In areas such as those that are densely populated and highly industrialized, the air in the lower layers is polluted by smoke, sulphur dioxide gas, and other products from the burning of coal and other fuels. Ordinarily these products are dispersed and diluted by air circulation or wind. But at times of fog, the products discharged into the lower layers of air that are stagnant or moving only very slowly, are dissipated only slowly and the concentration of the pollutants increases considerably. The result is a dark, sulphurous fog, or "smog" as it is effectively called in the U.S.A. The intensity of the "smog" is dependent to some extent on the length of duration of the period of fog or temperature inversion.

3. The Meteorological Office reported that the month of December, 1952, opened with frost and local fogs followed by milder weather on 3rd December. A large anti-cyclone reached the British Isles on 4th December and persisted until the 8th, causing frost and fog, which was particularly dense in the London area. Milder weather then spread eastwards and reached south-east England on 9th December.

4. The depth of the layer of fog in London and the surrounding districts seems to have been variable. A photograph indicated that on 8th December the top of the fog was clearly defined at Ranmore Common, Surrey, at a height of about 500 feet above sea-level. Hayes Common, Kent, at an altitude of about 250 feet was virtually clear of fog for the whole period. At Blackheath (Greenwich), it was reported at one time that the tops of the buses were above the fog at an altitude of about 160 feet. Yet to the north of London, hills reaching 400 feet or more above sea level were completely covered by fog, as far out as St. Albans.

5. At the Observatory at Kew, the velocity of the wind fell from about 12 miles an hour on 2nd December to less than 1 or 2 miles an hour from 5th to 8th December, while the direction moved generally from north-east to north-west, and north and then to south. Observations on the roof of the Air Ministry building in Kingsway, London, gave similar results with practically no wind from 5th to 8th December. The minimum temperatures recorded each day from 2nd to 10th December at Kew were in the range 24°F. to 39°F., while the maximum temperatures were from 32°F. to 43°F. Corresponding readings in Kingsway were 32°F. to 44°F. for the minimum temperatures, and 38°F. to 48°F. for the maximum

temperatures. There was thus a period of four or five days from 5th to 9th December with relatively low air temperatures and little or no wind.

6. In such circumstances, the smoke and other finely-divided particles and gases discharged from the numerous domestic and industrial chimneys at heights of less than a few hundred feet in the London area could not readily be dissipated and diluted, and the concentrations of the pollutants in the layers of air near ground level rose rapidly to unusually high amounts.

7. In various parts of the country there are now about 1,350 instruments in regular use and for special surveys for measuring pollution of the air by smoke, other solid matter, and gaseous sulphur dioxide. About 250 of these instruments are within a radius of 15 miles from the centre of London. Most of the 1,350 instruments are designed to give average results over monthly periods, and only about 140 are designed to give daily records. Of these 140 instruments, 30 are within 15 miles from the centre of London, and 24 of them are at sites not more than one mile from the River Thames. As intense fogs rarely persist for more than two or three days, only the daily records can satisfactorily be used to indicate the changes in intensity of pollution at times of fog.

8. It is instructive to consider the results for the 12 daily recording instruments at six sites in the Thames Valley from Westminster to Beckton. The averages of the daily measurements of the concentrations of smoke in the air over the three days 2nd to 4th December, 1952, at the several sites in this area ranged from 25 to 71 milligrammes per 100 cubic metres; and the corresponding concentrations of sulphur dioxide ranged from 10 to 21 parts per 100 million parts by volume. These concentrations are roughly in the same range as the averages for those sites in December, 1951, when there was no period of intense fog. During the fog from 5th to 8th December, 1952, the averages of the daily records at the same sites ranged from 103 to 375 milligrammes of smoke per 100 cubic metres, and 47 to 107 parts of sulphur dioxide per 100 million, or about five times the concentrations of smoke and sulphur dioxide on the three preceding days. On 7th and 8th December, 1952, the instruments at the County Hall in Lambeth recorded the high figures of 446 milligrammes of smoke per 100 cubic metres, and 134 parts of sulphur dioxide per 100 million.

9. It should be emphasized that these figures are averages of daily readings each over 24 hours, and that on any one day there may have been considerable fluctuations with concentrations at times much higher and much lower than the average for the day.

10. There were no measurements of the concentrations of carbon monoxide during the fog of December, 1952, but on the reasonable assumption that the concentration of this gas increased in roughly the same proportion as the increases in the concentrations of smoke and sulphur dioxide, and on the basis of measurements made at other times, it is probable that pollution by carbon monoxide reached highly undesirable amounts in some areas; and at points of dense and slow-moving traffic, the concentration may have become specially high at ground level by pollution from the exhaust gases of motor vehicles.

11. During the first four days of December, 1952, when the level of atmospheric pollution in London was normal for that time of the year, the number of deaths from all causes in Greater London (population about 8.5 million) as given by the General Register Office, ranged from 259 on 1st December to 321 on 3rd December. The number then increased sharply from 288 on 4th December to 406 on 5th December, and the increase continued to 910 on 8th December, which was the last day of the dense fog. There was then a rapid decrease to 543 on 10th December, with subsequently a more gradual decrease

to 425 on 15th December.

12. In early December, 1952, there was also fog in other parts of the country, and atmospheric pollution rose much above normal in several towns, including, for example, Glasgow, Kingston-upon-Hull, Leeds, and Salford. In no area, however, did the level of pollution remain so high as in London for so long.

13. It has already been mentioned that fog is a natural phenomenon resulting from certain unusual meteorological conditions, and that there is no known economic method of preventing or dispersing fog over large areas. There is no doubt, however, that determined efforts could lead to an appreciable reduction in the pollution of the atmosphere arising from the use of fuels, and thus to a reduction in the disagreeable and detrimental effects of fogs in the thickly-populated industrial areas.

(3) Report by Arnold Marsh, M.Sc.Tech., M.Inst.F.

General Secretary, N.S.A.S.

This contribution is intended only to draw attention to one or two aspects of the London Fog disaster that are not likely to have been dealt with in the preceding medical and scientific papers, but which are of particular interest to the Society in its work to create an informed public opinion on the need for smoke prevention.

To begin with it may be mentioned that the event severely stretched the Society's small organization by reason of the many inquiries we received, and especially the many visits and telephone discussions with eager but not always technically minded representatives of the press, at the very time we should have liked to have been making our own, more specific, inquiries and investigations. If ever there was a time when there was a need for a much bigger, wealthier organization to make possible the obtaining of facts and figures about some of the lesser consequences of the fog, this was it.

We knew that the health factors would be covered, and that the meteorological and other scientific aspects would be studied and analysed, but we knew also that no one would concern themselves with the more mundane material consequences of the event—the consequences that can mainly, though not entirely, be called economic. In other words, what had been the *cost* of it all to London?

The question has often been asked—we ourselves were asked it repeatedly—and although a few guarded guesses have been made it has been, and still is, impossible to give any precise reply. Compared with the deaths and the much more extensive illness and suffering, monetary cost is obviously of secondary importance, but it is nevertheless serious, as it means a waste of wealth in the form of material resources and human effort, that we can ill afford.

We were able to make one small selective inquiry only, as was reported in the " Fog Survey " in the Spring, 1953, issue of *Smokeless Air*. We asked about 25 of the larger shops and stores in London to give us their estimates of what the fog had cost their businesses. The replies were nearly all friendly and co-operative, and from them two main conclusions can be drawn: (*a*) that little definite statistical information is available, but what there is shows that the cost of smoke-fog to commerce is substantial; and (*b*) that on the whole the industrial and commercial world is hardly conscious of what they pay out because of smoke-fog (and smoke generally), largely because it is so familiar and merges into their general overheads.

The fall in turnover, or loss of trade, is the item most apparent to the shops, although to what extent this represents a real loss of wealth it is difficult to say. Such loss was put in one case at £11,000, while another store, estimated a loss of gross profit of £9,000. The cost of actual damage to stock in increased costs of cleaning, decorating, and so on, are in many cases known to be substantial, though it is apparently difficult to make close estimates. Only one store went into the question of loss of stock at all fully, and came to the conclusion that the loss was about £1,000.

There were many comments at the time of the fog on the filth it left behind, in homes as well as shops and offices, and no doubt the rate at which damage is always being done to property by the tar-soot-acid-grit complex of deposits was greatly accelerated during the period of fog. It all costs money and unnecessary labour to keep the dirt and destruction in check but once again it would need a very exhaustive investigation to determine the total with any exactness.

To these direct costs should be added a proportion of those due to the dislocation of traffic—road, rail and air—and the loss of production that this entails. There would of course be fog without the presence of smoke, but the smoke makes the fog darker, denser and of longer duration. Additional lighting due to the darkness of smoke-impregnated fog is another cost that must be added.

On the most conservative basis it is highly probable that the cost of a day's heavy smoke-fog in London must be well up in the millions range.

Although it would be most useful to have a fairly exact figure for propaganda purposes it may be wondered whether, even if funds for the necessary investigations existed, it would be really worth while. It was known that Everest was a remarkably high mountain even before its height was measured, and sensible people should be able to appreciate for themselves, from the sample information we do possess, that the economic cost of smoke and fog is very heavy indeed. And the less sensible are not likely to be impressed by greater precision anyhow.

More important than the heavy cost of smoke-fog, which is only occasional and of short duration, are the chronic, year-in-year-out losses due to air pollution generally. It is just as difficult to obtain any precise figures for these costs, though the overall national cost of £150 millions, which was the figure recently given in those excellent *Times* articles, is reasonable. It means an *average* annual cost of £3 per head of population, which is of the same order, and may be compared with the £7 per head that it has recently been estimated is being *saved* in Pittsburgh as a result of successful smoke prevention measures.

This lack of definite information about the cost of smoke is due in part to the fact that it is admittedly difficult to extract it, but in part also because it is so familiar and so much a " natural " part of city life in this country that it ceases to be noticed. We have reported in *Smokeless Air* the surprised admission of a leading industrialist in Pittsburgh that the energetic smoke prevention measures they have carried through should have given such spiritual uplift to the people. If they had realized it, he said, " we would have been fighting for it long before."

In the same way we in this country have been agreeably surprised at the warmth of the approval for the smokeless zone in Manchester expressed by members of the business community. One must conclude that only when smoke has been abolished do people realize what they have been putting up with. The effects of smoke and smog are not as easily seen and understood as such simple, elemental catastrophes as floods, earthquakes, air or rail crashes. There is little drama and news value about deaths from bronchitis, and in any case they do not lend themselves to startling photographs in the papers. The smoke abatement movement still has a hard psychological nut to crack in

putting its case across to the public. A great deal could be said about that, but for the purposes of this contribution it need only be said that the factors that make it difficult to stir up people about smoke were the same as those which prevented the London fog disaster from being recognised as something even more disastrous—in terms of human life—than the East Coast floods. Even the Lynmouth disaster created far more attention in the press, and evoked far more sympathy than did the 4,000 deaths and tens of thousands of painfully ill and distressed people in the London fog.

It is a moot point whether the press creates or follows public opinion, but between them, press and public, the fog created amazingly little concern. There have been, of course, a number of outspoken articles and leaders, and some blunt headlines and phrases, such as: "Forgotten Massacre," and

> "Last December fog caused in London a major calamity. Because there were no bodies lying in the streets, because there was no blood on the pavement, the full significance of that calamity did not penetrate the consciousness of the nation as a whole."

"Did not penetrate the consciousness of the nation as a whole." That sums up the position pretty well. How can we make the penetration? In the first place we can hope that the new Beaver Committee will remember that it can perform a signal service to the fight for clean air by addressing its report not only to the Ministries but, in a forthright fashion, to the public as well. The same applies to the Ministry of Health's medical inquiry. Their report might be in a form that will impress only the medical world and be given careful consideration only in the medical press, but it may be suggested that there may be an opportunity to give the public the salutary shock it so badly needs.

These two reports, to which we look forward with expectancy, can do much; but it must be remembered that reports are published only once, and no matter how hard their immediate impact, can only too quickly be forgotten. Continuity and reiteration are essentials of publicity, and that is where the N.S.A.S., armed with new evidence and (we hope) drastic recommendations, can come in.

A great deal more action could be taken even now, but for the more radical measures that are necessary action must be backed by public opinion. Up to now we have been painfully trying to create public opinion on a problem of vital national importance with an annual income that other campaigns would exhaust in a month or even a week. This is not the occasion to discuss the Society's needs and the work it could start if those needs were met, but the implications should be obvious.

COMMENTARY UPON SMOKELESS ZONES

Dr. T. Morrison Clayton, M.D., B.S., B.Hy., D.P.H.

Medical Officer of Health, Coventry

We cannot surely be too happy about existing legislation which has made little advancement during the past 75 years and has obliged progressive local authorities to seek other means by which the emission of smoke can be eliminated and so prevent pollution of the atmosphere from this source.

At the present time action under Section 101 of the Public Health Act, 1936, can be taken only after a nuisance has occurred and even then, private houses which obviously contribute enormously to pollution of the atmosphere by smoke, are exempt from these provisions of the Act.

It was the late Charles Gandy who, some twenty years ago, suggested the creation of smokeless zones as a radical means of dealing with the smoke problem. The idea is a positive means of preventing pollution by smoke originating from all sources and is one which an increasing number of authorities are now adopting. The immediate advantages to be gained from such a system operating in many of the large industrial towns and conurbations will be apparent.

Many authorities have no serious smoke problems but the modern tendency to factory dispersals for strategic and other reasons may reduce this number as industrial redevelopment achieves a still greater capacity. Apart from this prognostication however and since smoke takes no regard for boundaries, it is essential to the practical success of smokeless zoning that the maximum number of authorities with smoke pollution problems should promote their own legislative remedies. By such means will the community derive full advantages not only in the districts directly concerned but also in the surrounding, and perhaps fortuitously, less industrialised areas.

There is ample contemporary evidence that this " new " method of smoke control is gaining favour since at least fifteen local authorities have already obtained the necessary powers in Private Acts to establish their own smokeless zones: others too have the matter under consideration.

The success of this approach to the problem is made more evident by the recent proposal of the Manchester Corporation to extend their initial zone to more than twice its original area. Details of this extension will be found in an interesting article published recently (4th July, 1953) in *The Medical Officer*, by Dr. C. Metcalfe Brown, Medical Officer of Health, Manchester.

In Coventry we too are proposing to extend our own zone (which you will recall has been operating since 1st March, 1951) by over 100 per cent. We do not of course suffer from the degree of heavy atmospheric pollution so evident in certain other industrialized areas, since very many of our factories are modern and almost completely electrilized so far as machinery motive power is concerned. We feel nevertheless that an extension would be a real contribution to the amenities of the city and health of its population.

Local Acts of Parliament vary in some respects from area to area and these devi tions are probably accounted for by the differences in particular requirements by the various local authorities: maybe also to an extent by the inconsistencies of central government in allowing a stricter form

of control in one local Act than another. There are indications however, that the Government is keeping a watchful eye upon the progress of these Acts and is presumably amassing useful information on the practical workings of smokeless zones to be utilized as a basis for nationally permitted zoning.

It is estimated that the average citizen would fail to be impressed by the reduction of atmospheric pollution in any particular area unless the diminution was of the order of 50 per cent. to 75 per cent. at least. Pollution reductions of from 25 per cent. to 30 per cent. are estimated to be possible however, at the centre of a square mile "free" from smoke emission. It is apparent therefore, that any initial smokeless zones, proposed or in existence, will need to be considerably enlarged before any further noticeable effect is perceived by the local inhabitants. Consequently impressive pollution reductions can only be achieved by a practical application of the smokeless principle to very large areas or to continuously enlarged zones over a period of several years. From experience we may reasonably assume that our legislators will be more effectively influenced by concrete figures of pollution reductions rather than by the propagation of abstract or fanciful ideas.

Under such circumstances therefore, the prospect for widespread zoning throughout the country could not be considered as particularly encouraging. It is doubtful in view of the urgency for industrial development, whether the Government would be readily converted to the introduction of national legislation to constitute smokeless zones unless there occurred in the public mind an irrepressible desire and overwhelming expression for unpolluted air.

Established or contemplated smokeless zones in various parts of the country fall roughly into four categories. They are :

(*a*) industrial areas with heavy atmospheric pollution, e.g., Manchester, Bolton, Rochdale, Salford.

(*b*) industrial areas with a moderate degree of pollution but where due to extensive war-time damage, large scale rebuilding and redevelopment is planned, e.g., Coventry.

(*c*) residential areas in process of development, e.g., Manchester.

(*d*) areas of all types in the vicinity of airports, e.g., Manchester's Ringway Airport.

Apart from the primary reasons for the establishment of all smokeless zones there are essential differences of intention between the four categories (*a*), (*b*), (*c*) and (*d*). The primary reason in categories (*a*) and (*d*) is apparent and straightforward. In categories (*b*) and (*c*) the emphasis is more directly concerned with planning for the future, the opportunity being available for the introduction of a positive principle to improve health and amenity and which under more normal circumstances would usually be unacceptable.

When (as in the instances of large scale building projects and in the reconstruction of devastated cities through war damage) the seemingly less material advantage of smokeless air can be linked with and form a valuable supplement to a challenging and ambitious plan of re-creation or extension of civic advancement, then acceptance of control usually follows.

While in the cases of (*a*) and (*b*) the object is to reduce the aggregate of atmospheric pollution, it is nevertheless essential that the initial zones should be sufficiently large to produce an appreciable diminution in pollution, otherwise the disappointing visible achievement is liable to cause a waning of enthusiasm for a long term and more extensive policy.

A far reaching enactment prohibiting smoke emission would probably meet with strong opposition. Conversely, legislation designed to secure smoke prohibition in limited areas would be more likely to achieve its object. Moreover, the extent of the

initial upheaval and probable intensity of opposition could be gauged within reasonable limits by the appropriate local government officers who have intimate acquaintance of local conditions. Opposition to any idea which has as its outcome the improvement of health and environment should not deter a progressive authority from achieving its objective, providing it is alive to impending difficulties.

The general public is becoming increasingly aware of the adverse effects of smoke pollution upon health and amenity and indeed, current official investigations are attempting to determine the degree of this hazard. Certain local authority schemes might well be bitterly opposed by the public if further financial burdens are to fall upon them. One local authority, Salford, has anticipated this difficulty and has provided in its Act for the payment of compensation up to a maximum of £2 per house. It thereby assists in the alteration or suitable adaptation of existing fuel burning appliances or in the introduction of more modern equipment. Solid fuel may thus be consumed without contravening the local provisions. Furthermore under the Housing Act, 1949, where a local authority has made a grant for the improvement of a house, conditions could be stipulated whereby any scheme which involves alterations to, or installation of fuel burning appliances, whether for space heating or water heating, should be of such a character as to assist the burning of solid smokeless fuels (i.e., " prior approval ").

The existence of large industrial establishments or public utility undertakings within a proposed zone, or extension to a zone, may present considerable difficulties, not least being the cost involved for replacement or adaptation. There is really little need to make the passing of a Private Act more difficult by inviting opposition from industrialists.

In Coventry we feel the best approach is to establish as large an initial zone as is reasonably compatible with the weight of opposition. In those local authority areas, however, where there seems to be insurmountable difficulties, it may be wiser to offer temporary dispensation to certain factories from participating in the initial zone. Thereafter smoke producing plants might well be considered for inclusion in any subsequent extension of the area. Such zones would not be fully smokeless but would constitute an advanced step in that direction and would be an incentive to the temporarily excluded premises to achieve a smokeless status.

Domestic premises possibly present the most difficult problem, there being a distinction between domiciliary smoke production and that of business premises and factories. In the latter two instances the personal factor does not enter into consideration, the primary factor being cost and convenience. Moreover, factories could be excluded from a particular zone in the first instance and indeed, modern boiler plants under skilled control can operate without the emission of much smoke. Dwelling houses are a vastly different proposition and the majority of older type domiciliary heating appliances were designed to burn fuel without much thought having been given to efficient combustion. It is well nigh impossible to burn bituminous coal in the open fire grate without considerable smoke emission.

The efficiency of the open grate has been much improved of recent years but even so the burning of ordinary coal on such equipment would seemingly be out of the question in a smokeless zone. Most of the modern grates have been designed to burn solid smokeless fuels and the majority of post-war houses have probably had them fitted and so can consume smokeless fuel without contravention.

Inclusion of dwelling houses within a smokeless zone might well involve payment of compensation to help ensure the requisite alteration to fittings (cf. Salford). An ambitious scheme may thus involve a local

authority in considerable expenditure and consequently the advantages of the project would need to be weighed against the costs. An essential requirement would be to ensure an adequate supply of acceptable solid smokeless fuels and the outlook for this is not too bright. Indeed, it is a matter of great concern that the Ministry of Housing and Local Government has refused to confirm the Order for establishing smokeless zones in Salford because the supply of smokeless fuels is inadequate.

We are constantly reminded that coal production is lagging behind consumption and we are entitled to assume from this that the manufacture of smokeless fuels is unlikely to increase until the pendulum swings the other way. There may be a sufficiency of these fuels to meet the present moderate requirements but extensions of smokeless zones involving large numbers of dwelling houses may quickly embarrass special fuel production and create extensive shortages. Under such conditions it would be futile to enforce the provisions of any Act relating to smokeless zones and consequently the Ministry's decision concerning Salford will probably discourage many local authorities from embarking upon similar schemes for the time being.

It has been suggested that the Government may be remaining aloof from active participation in furthering schemes for smokeless zones until they have had an opportunity to review the experiences within those zones already approved and to assess the likely reactions to a nationally legislated scheme.

Be that as it may, a comprehensive organisation of certain aspects of zoning must inevitably eventuate if there is to be a practical advancement in the more general concept of a smoke free atmosphere.

The existing Private Acts of certain local authorities which are as yet, or will be, functioning separately, will eventually need some form of general co-ordination—possibly along the lines of the Domestic Fuel Policy Report (e.g., standardization of domestic fuel burning appliances). It seems equally rational and important that the availability of solid smokeless fuels for approved smokeless zones should be co-ordinated upon a wide basis and, moreover, that their standards of composition should be designated within fairly precise limits: otherwise their efficiency and " smokelessness " is liable to be unduly criticized.

Discussion

Councillor Miss P. C. Paton Walsh (Westminster) stated that she had listened with great interest to the papers on the London fog and to the discussion which followed. It could not be sufficiently emphasized that the London fog of last December was a great calamity. Miss Paton Walsh said she spoke as one who had suffered all its inconvenience as well as feeling personally ill from its effects, as had many thousands of her fellow Londoners. Dr. Clayton, in his most interesting paper, advocated the establishment of smokeless zones, and while in full sympathy Miss Paton Walsh said she wondered why no mention had been made of the contribution to a cleaner atmosphere which could be made by district heating.

Miss Paton Walsh said she had the honour to represent the City of Westminster, and her Council was proud of the fact that its post-war housing estates were supplied with central heating and hot water by a district heating scheme—the first of its kind in London which made use of the exhaust steam from Battersea Power Station. By that means the coal burned in any case at the power station provided space heating and hot water to the flats, and was burned much more efficiently than it could be in the thousands of small domestic hearths which would otherwise be necessary; also in such a concentrated plant it was easier to introduce cleaning processes.

The estate to which she referred in particular, known as Churchill Gardens,

lay on the north bank of the Thames opposite the power station. At present some 1,800 flats were served. This included 1,200 in a large block of privately owned property and the scheme had proved entirely satisfactory. The Westminster City Council's estates, when fully developed in the course of the next few years, would bring the total number of flats served to over 3,000. Miss Paton Walsh pointed out that this was the equivalent of a small town and was in itself a smokeless zone because in effect no fuel of any kind was consumed in these flats. She hoped that other boroughs might follow Westminster's lead, particularly those in the riverside areas. She trusted that other district heating projects would be explored, because she believed they offered the most positive contribution to smoke abatement and the economic use of coal. Miss Paton Walsh asked whether Dr. Clayton would give his views on the various methods at present known of district heating. Would it be better to concentrate on hydro-electric power? Would that not eliminate the smoke nuisance altogether?

Alderman G. H. Goulden (Salford) referred to the past history of the Society as one of great endeavour and great educational progress, culminating now in some recognition of its efforts. Public opinion was now behind the Society. Government committees under Egerton, Simon and Ridley and now the Productivity Council, recently returned from the United States, had all indicated that our methods of fuel utilization were antiquated, leading only to the production of more and more smoke, more and more waste, which the nation could ill afford.

All of this had been known for years, and the Beaver Committee on Air Pollution now sitting would present a report to prove once again what was already known. The lethal smoke and polluted atmosphere remained, the national economy was seriously affected, but there was still no lead and little encouragement from the top.

The Salford Council agreed to schedule a large residential area as a smokeless zone. They were satisfied on the theoretical aspects and had taken care to investigate the practical aspects. All that was required was Ministry sanction. This was not forthcoming—there was not even a reduced or modified recommendation. In view of the London fog disaster, Alderman Goulden felt the Minister had taken an awful risk with the lives of people living in the area. Many lessons could have been learned from the Salford scheme.

Local Councils' powers were inadequate to reduce industrial smoke to a minimum. It conferred almost complete immunity on certain trades and processes, and domestic smoke production remained uncontrolled.

The allocation of £1 million as an inducement to industrial equipment improvement was but a pious concession to the recommendations of committee after committee. Greater material incentives were needed such as tax rebate on the expenditure involved. Industrial hospitality expenses were considered proper items for tax exemption. Grants towards conversion costs of new grates too would not be blind investment. The resulting fuel economy, the return in terms of efficiency, the saving of lives and the promotion of better health would far outweigh the capital outlay. It was as important to rid the atmosphere of pollution as it was to maintain an efficient Health Service.

The difficulties were increased by the lack of co-ordination between the coal, electricity and gas boards. The Minister of Fuel's talk of " unbridled " competition between them was utter nonsense. After all the main objective of the boards was to provide services, not to indulge in cut-throat competition. Each had its own sphere of influence in the power, heating and lighting needs of the nation. There need be only one sales organization instead of three, with three showrooms providing advisory services on the best fuel for particular circumstances rather than each pressing its own commodity to the exclusion of the other two—" nutty slack " for instance.

" Smog " disasters could only be avoided by making it possible for all consumers to afford and choose the smokeless fuels the nationalized services control. The glow of good health would return to all Britons when they could indulge in the warmth and rosy glow of a smokeless fire.

Skirmishing and sparring should be over. The Society was presented with its most glorious opportunity to prove and continue its leadership in the fight. Only action at Government level could speed forth recognition of the proven opinion of the Society that clean air could be a reality, was practical economics, and was attainable in measurable time. He urged the expression of that opinion

o the Minister with all the emphasis the importance of the situation demanded.

. C. G. Isaac in discussing the London og said that it might be of interest to now the results of some research which as at present being undertaken at the larvard School of Public Health in oston, Massachusetts. The information iven was taken from a private comunication from Dr. Mary Amdur, part f which would shortly be published in he *Lancet*.

Fourteen adults in normal health were xposed to controlled concentrations of O_2 ranging from 1 to 8 p.p.m.; all howed changes in respiration and pulse ate. While the minute volume remained nchanged, the tidal volume decreased, he respiratory rate increased and the ulse rate increased. For example, the hean values of these measurements for ve subjects exposed to 5 p.p.m. SO_2 for 0 minutes indicated a rapid reduction in idal volume reaching about 25 per cent. elow the control value at about 4 hinutes after the start of exposure. espiratory rate increased 3-4 breaths per hinute over the period of exposure and ulse rate increased 8-9 beats per minute. hese values all returned to normal ithin 10 minutes of the end of exposure. imilar results were obtained on exposure o 1 p.p.m. of SO_2 though there was, in hat case, some recovery towards the end f the ten-minute exposure.

It was found by Dr. Amdur that where ubjects regularly breathing SO_2 were xposed to 5 p.p.m. similar changes were ot shown. That indicated an apparent olerance to SO_2 though Haggard J.Indust.Hyg. and Toxicol 5 (1923) 390) ad written that the apparent tolerance in uch cases was due to chronic inflammaon of the upper respiratory passages, roducing a tenacious mucus which acted s a protective coating; in his opinion, his deadening of the reflex had removed ne line of defence against the irritant.

This investigation established the fact hat SO_2 even in concentrations as low as p.p.m. produced rapid, shallow breathng, and increased the pulse rate. Dr. mdur and her colleagues (Amdur, M. O., ilverman, L. and Drinker P., Arch. ndust.Hyg. and Occ.Med. 6 (1952) 305) ad previously shown that very similar hanges were produced by sulphuric acid hist in concentrations as low as 0.35 ng./cu. metre. (Sulphuric acid had been hown by Coste and Courtier (Trans. araday Soc. 32 (1936) 1198) to be present n London fogs).

At these low concentrations it was unlikely that either SO_2 or sulphuric acid would harm an individual in normal health. No studies had so far been made on those suffering from cardio-respiratory disease, but it seemed likely that the added strain of the observed effects might well produce damaging results when superimposed on the existing disease condition. There was some evidence that sulphur dioxide and sulphuric acid might act synergistically to produce an effect much greater than would be expected from the separate effects of either. For example, La Belle (Abstract in Chem. Engg. News 31 (29 June, 1953) 2655) had shown that ordinarily non-toxic substances when carried deep into the lungs on an aerosol produced dramatic results. Dr. Amdur (personal communication) had shown that, whereas neither 89 p.p.m. of SO_2 nor 7 mg./cu. metre of sulphuric acid mist used separately produced respiratory symptoms and little lung pathology on guinea pigs after an eight-hour exposure, the effect of the two agents together produced extensive damage to the lungs of the animals.

James Law (Sheffield) said that since December last most people had read with interest, and perhaps an amount of dismay, what took place at that time and the aftermath in mortality, particularly among the older people who were affected by the asphyxiating atmosphere which was prevalent.

It was felt that tribute should be paid to the authors of the three papers dealing with the subject for the concise manner in which the statistics and facts had been briefly explained.

It did appear to be a lamentable fact, however, that it took a disaster of that kind to shake some people out of their lethargy, because the " writing had been on the wall " with regard to it for some years.

Many of the delegates may have remembered a paper given at Margate in 1950 by Dr. Burnett, who reviewed the Donora Incident in Pennsylvania and the Meuse Valley in Belgium. In the discussion it was pointed out by Mr. Law that " the pollution of the atmosphere was on the increase and that though it had not become a definite menace, there was no guarantee that atmospheric conditions might not at any time cause such incidents to occur in any town in Britain." It had occurred, and it had given the people a Special Government Committee who would investigate the causes, review the

present preventive measures and put forward, it was hoped, recommendations that would be made use of, in order to prevent a recurrence of the London disaster.

It was hoped by many of them that an opportunity to contribute to those recommendations would occur, and it was with that object that Mr. Law was taking part in the discussion.

It was stated that in most areas smoke abatement was a part-time job which was carried out when the sanitary staff were not too busy with other health matters. The total number of full-time smoke abatement officers in Great Britain was about 28, and if Birmingham, Glasgow, Manchester, Nottingham, Liverpool and Sheffield staffs were taken, the majority was employed there, and the rest of the country only carried out the work in conjunction with other matters as a part-time occupation. He said he was open to contradiction, but he did not think that any of the Metropolitan or Greater London Boroughs employed a full-time smoke abatement officer, nor did they have a Regional Smoke Abatement Committee with any statutory powers. Perhaps the London people would correct him if he was wrong. He was not going to suggest that the fog or the disaster was in any way due to the lack of inspectorate, but he was going to state quite definitely that an area of the size and congestion of London should have a consolidated Regional Committee vested with full statutory powers, and a competent staff of qualified full-time inspectors, to control nuisance when it occurred, if there was to be any preventive measure of avoiding what happened in December last.

He wondered, after criticizing London, if he dare say anything about Smokeless Zones and the development of the same. Dr. Clayton in his commentary placed those under four categories, namely: (*a*) heavy industrial areas, (*b*) moderate industrial areas, (*c*) residential areas, and (*d*) airport vicinities. Mr. Law was pleased to note that he emphasized the difficulties that could be met with in (*a*) and (*b*).

In many of the large cities and towns the lack of vision and planning had caused such a mixture of industry, commerce and dwelling houses, that for the time being "smokeless zoning" was just impossible. A recent survey of the centre of Sheffield showed that 44 per cent. of the premises were smokeless, 33 per cent. could be made so without heavy expenditure, but that the other 23 per cent. either were impracticable or would cause such upheaval that for the time being they could not be considered.

It was noted that at Manchester and Salford compensation was being allowed for in the declaration of such zones, and that may become a serious matter with many authorities who had inclinations for a smokeless zone. The suggestion arose—"Were we working on the right lines with smokeless zones?" No one at that Conference or elsewhere would state that the idea of such zones was not a move in the right direction, but why start in the centre of the city?

Most of the cities and towns had specified parts set aside for development, or even as open spaces, which were situated round the periphery. Was it not much better to declare those areas as "smokeless zones" so that when they were developed they would remain so? There would be little or no opposition to such declarations. There would be no compensation asked for, and it appeared to be a more rational method to commence at the periphery that was not developed, and work gradually to the centre, than to declare small central areas where development or extension was difficult and opposition was strong. He said that he would appreciate Dr. Clayton's opinion on that subject and that of any other delegate who had similar views of smokeless zones.

Councillor F. Hilson (Droylsden) said that the apathetic attitude of the Press, referred to in the paper by Mr. Arnold Marsh, was apparent in one of that day's editions of a well-known national newspaper, which had allotted a meagre 2-inch column to conference matters, suggesting that "smogs" also occurred around the editors' offices of some of our daily newspapers. It was, however, pleasing to place on record the fact that a local newspaper circulating in the Droylsden district (the Ashton-under-Lyne reporter) was interested in our cause and had agreed to print a series of articles on smoke abatement.

When considering the establishment of a smokeless zone in a small urban district, one always came up against the Chairman of the Finance Committee, and quite rightly so in view of the problem of finding the necessary money from an already over-burdened rate fund. There was surely a case for co-operation among various local authorities in sharing the

ost of the promotion of a Private Bill. uch areas as south-east Lancashire, and erhaps the Midlands were typical subjects for a course of action along those nes.

Finally, a practical and worthwhile ontribution could be made if all the ouncillors present returned to their istricts and preached an effective gospel f smoke abatement to their fellow ouncillors, from whom it was not ncommon to hear the age-old fallacy, There's nothing to beat a good, blazing, pen, coal fire."

. H. Wilkinson (Corby) paraphrasing Mr. Marsh's quotation, thought it was robably true to say that atmospheric ollution had not penetrated the conciousness of local government as a whole. Only 20 per cent. of all local authorities were members of the Society, and less than per cent. were operating measuring nstruments.

Publicity based upon the present nedical evidence of ill-effects on health was ineffective because it was based on onjectures and not concrete facts. He isagreed with the theory that because it would appear that high concentrations of ir impurities caused serious illness and ven death, therefore it automatically ollowed that ill-effects of a proportionate esser degree would result from long-term xposure to lower concentrations. The urgeon-General to the U.S. Federal ecurity Agency had aptly summed up he position in his foreword to the Donora Report—" The Report has shown with reat clarity how little fundamental nowledge exists regarding possible effects f atmospheric pollution on health." Whilst injury to health and damage to roperty had been cited in the case against ollution, plain dirtiness had been a basic notive for efforts to reduce it. Perhaps would be better to base our propaganda n the fact that pollution was just a errible nuisance.

Of the apparent general apathy in local overnment on the matter of air pollution ontrol, he pointed out that at present owers and duties rested solely with local uthorities. The government committee of investigation would make everal recommendations. It was proable that local authorities would be sked to do much more than they had one so far. If local government was not repared to carry out these additional uties, the only alternative would be ransfer of functions, and only local overnment itself would be to blame. Never let it be said that local government willingly gave up any of its powers because it could not find the time or the money to carry them out.

Dr. H. E. Crossley (British Electricity Authority) said that following a disaster as serious as the London fog, it was natural that there should be public indignation, but some of the published expressions of opinion had caused considerable confusion and overstated the case. The word " murder " had been used on several occasions applied to the fumes from various chimneys, whereas, of course, however grave the disaster, this word did not apply. Sir John Charles had said in the Memorial Lecture on the previous day, many scientific problems regarding fog deaths remained to be solved, particularly in attempts to clarify the causes of fog deaths. He would like to correct a misunderstanding: there had been accusations made against the big power stations which burn quantities of coal of the order of a million tons a year. At these power stations the height at which the chimney gases were released, and the temperature and velocity of the gases were such that the emissions would rise above a fog belt such as that which affected London. He would not ask them to accept scientific evidence alone, but they might care to think about the fact that where stations of the kind mentioned were surrounded by only a few houses in villages and with little else to contribute to pollution, there had been no record of fog disaster during the last winter. This applied, for example, to Little Barford, Llynfi, and particularly to Hams Hall, one of the biggest generation sites.

It was futile to discuss long-term plans for the avoidance of further fog disasters when the next fog disaster could happen in weeks or possibly even in days. Further, too much faith had been placed in the efficiency of smokeless fuels. Manufactured smokeless fuels carried the same order of amounts of substances such as sulphur, chlorine and fluorine as the coals from which the fuels were made, and any of those substances might have contributed significantly to the toxic quality of the London fog. Smokeless fuel alone, therefore, was not the answer to the present problem of what was to be done to prevent a recurrence of the disaster. The major blame could be placed squarely on the domestic fire with its low level emission and if a dense fog became stable in a big city the most direct way of

avoiding fog deaths would be for householders to avoid burning solid fuel during the period of the fog and rely upon other methods of heating.

G. W. Farquharson (Birmingham) said that the reports indicated the complexity, magnitude and obstinacy of the problem. Dr. Scott had introduced the possibilities of the toxic effects of some of the non-toxic products of combustion when carried to the lungs, and Dr. Parker suggested that carbon monoxide could reach undesirable amounts in certain areas and dense traffic. He would ask Dr. Scott his opinion on whether it was possible for such experimental work in artificial smoke polluted fog to be carried out through any of the recognized medical research organizations in this country, so that evidence one way or the other could be submitted to the Committee of Inquiry now set up.

All the reports ended up with appeals for more to be done. Dr. Scott suggested the abolition of nutty slack. It was agreed, but what was the position? A fortnight ago the Midland Regional Fuel Controller, when reviewing the coal position in regard to stocks, had stated they were down by thousands of tons for industrial and domestic uses, and manufacturers were being urged that wherever possible they should accept opencast unscreened coal, and whilst attempts were being made to keep back large coal for domestic purposes, domestic consumers were to be urged to take alternative supplies such as unrationed coal. It was hoped that this position would not materialize and that the Ministry of Fuel and Power would not embark on a campaign similar to last year, urging householders to use that fuel for overnight burning in the approved appliances.

In his reply **Dr. Scott** indicated the concern with which he viewed the statement by Dr. Crossley of the British Electricity Authority. There were some 20 major power stations in London each burning from 1,000 to 2,000 tons of coal a day, and comparisons with the position elsewhere were completely invalid.

He also made a brief reference to the questions raised by Mr. Farquharson on experimental work.

In his reply **Dr. Parker** said that Miss Paton Walsh had suggested that air pollution by smoke might be considerably reduced by a great extension of district heating schemes, and possibly by increased production of electricity by hydro-electric schemes. Dr. Parker agreed that there need be little pollution by smoke with either straight district heating schemes, with a large central boiler installation, or district heating from thermal-electric installations. Some extension of such schemes might be practicable, but the extensions could not be appreciable without undue cost. If district heating schemes were not to be wasteful in fuel and other ways, there must be developed some satisfactory method of measuring the amount of heat taken by each householder. In the absence of such a method of measurement of heat taken, householders were wasteful in their use of the heat. This had already been proved with the district heating schemes already in operation. In these schemes there was a flat rate charge added to the rent, so that householders who took more from the heat service than was really necessary were not penalized by having to pay more. The amount of electricity generated by hydro-electric schemes in Great Britain was no more than 3 per cent. of the total quantity of electricity generated and it was unlikely, with our limited water resources, that that percentage would be appreciably increased.

Alderman Goulden of Salford had deprecated the use of "nutty slack." Measurements at the Fuel Research Station had indicated that the amount of smoke emitted from a domestic fire grate in relation to the amount of coal burned was not greatly affected by the size of the coal; for coals of the same type it was about the same for coal in nut size as for coal containing a large amount of slack. Different types of coal, irrespective of size, gave different amounts of smoke. If householders used more fuel by overnight-banking of the fires instead of re-lighting the fire each morning, then the total quantity of smoke would be greater.

SOLID SMOKELESS FUELS

(Session arranged in co-operation with the Solid Smokeless Fuels Federation, on behalf of which both papers have been prepared)

(1) PRODUCTION AND UTILIZATION

by

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Introduction

The purpose of this paper is to give an account of the production and utilization of solid smokeless fuels at present in commerce in Great Britain and accordingly it is divided into two main sections. Part 1 deals with production, either by mining or manufacture, and with the subsequent preparation, sizing, cleaning, etc., which produces the fuel as sold to the public. This part contains only an outline of the production methods as these have been fully covered in recent issues (Nos. 76 to 80 inclusive) of the Society's journal *Smokeless Air* in which appeared a series of articles under the heading "Smokeless Fuels Review." Part 2 of this paper deals with utilization. Here some selection has been necessary since the subject is a very wide one. It has been felt that it would be helpful to the Conference and the Society generally to deal with utilization in its application to the problems of Smokeless Zones and it is the hope of the authors that further problems not included in the paper will be brought forward in discussion.

PART 1. PRODUCTION

The fuels under consideration fall into two classes. These are the natural smokeless fuels and the manufactured fuels. The latter comprise high and low temperature cokes and carbonized ovoids ("Phurnacite").

Natural Smokeless Fuels

The natural smokeless fuels, Anthracite and Dry Steam coal are produced mainly in South Wales with additional supplies of Anthracite from the Scottish coalfields.

True Anthracite is smooth and shiny in appearance; it has a low volatile matter content, generally within the range of 5 to 10 per cent. and burns in most appliances with a short bluish flame. In comparison with Anthracite the Dry Steam coals are rougher and duller in appearance, the range of volatile matter content is generally 10.0 to 14.0 per cent. and these coals burn freely with a longer and slightly luminous flame. Both the Anthracites and the Dry Steam coals have a high bulk density and low ash content (the Anthracites 2 to 7 per cent. and the Dry Steam coals 3 to 8 per cent.). These two properties ensure long burning periods without the necessity either for replenishing the fuel bed or for removal of ash. Indeed the less the fuel bed is disturbed the better; gentle removal of ash is essential for best results and fuel economy.

Manufactured Fuels

In this class of fuel there are four main varieties. These are gas coke, hard coke, low temperature coke, and carbonized ovoids ("Phurnacite"). All have in common the fact that at some stage of manufacture the fuel is carbonized, that is, subjected to heat treatment to drive off some of the volatile components present in the coal from which the fuel is manufactured. This is an important stage in manufacture which renders the fuel smokeless. At the same time the volatile matter which would have formed smoke is an extremely valuable source of chemical products of a wide variety. With the exception of " Phurnacite " these fuels are manufactured from high volatile bituminous coals.

The ash content of all cokes varies widely according to the ash content of the coals from which they are manufactured; they vary in bulk density, being high in the hard cokes and low in the low temperature cokes, but all cokes are much less dense than the natural smokeless fuels. For this reason it is customary to operate appliances with a deeper fuel bed when burning cokes. Further, clearing of the ash from the fuel bed should be carried out more vigorously than is necessary with the natural smokeless fuels.

Production of Natural Fuels

Anthracite and Dry Steam coal occur in seams varying in thickness from 18 inches to 10 feet or so. These seams lie between strata or layers of shale or rock and an essential part of the preparation of the fuel for the market consists of removing the admixed shale or rock (generally known as " dirt ") which is brought to the surface mixed with the coal. In the past, when hand cutting and loading methods only were used, much of this " dirt " was rejected by the miner before the coal was brought to the surface. To intensify production, mechanical cutting and loading are now used: this does not differentiate between coal and " dirt " and thus more extensive cleaning plants have now to be provided.

Fig. 1 (*a*) illustrates a coal preparation plant. The coal is brought to the pithead in " tubs " or trams which proceed after weighing to the colliery screens. Here the tubs are discharged on to mechanically-operated screens which remove all the material below 5 in. in size. The plus 5 in. material which passes over the screen meshes is then carried forward on picking belts (see Fig. 2 (*a*)) beside which pickers stand to remove pieces of shale and stone by hand, after which it is either loaded into wagons for despatch as large coal, or is passed through a " breaker " which breaks the large pieces down to smaller sizes required for the market.

The material passing through the 5 in. screen and the broken large coal is conveyed to the coal preparation plant for further treatment, where the untreated coal is first divided into two or more fractions for separate treatment.

In the new plants, some of which are already in course of construction, the whole of the output will be mechanically cleaned by a combination of modern washing processes, which will ensure the maximum removal of " dirt " with the minimum loss of coal in the discard.

There are several types of washer used for cleaning coal but the principle upon which they all work is based on the fact that coal is lighter than the " dirt " mixed with it during mining operations. One of the best known and most widely-used types of washer is the " jig " or Baum which consists of a large tank in which water is caused to pulsate thereby bringing the coal to the surface and the " dirt " to the bottom as the raw coal passes through in a continuous stream. The clean coal and " dirt " are drawn off separately as the apparatus operates.

A more recent system used for cleaning coal is that known as the " heavy medium " or gravity washer which works on the float and sink principle. The bath into which the

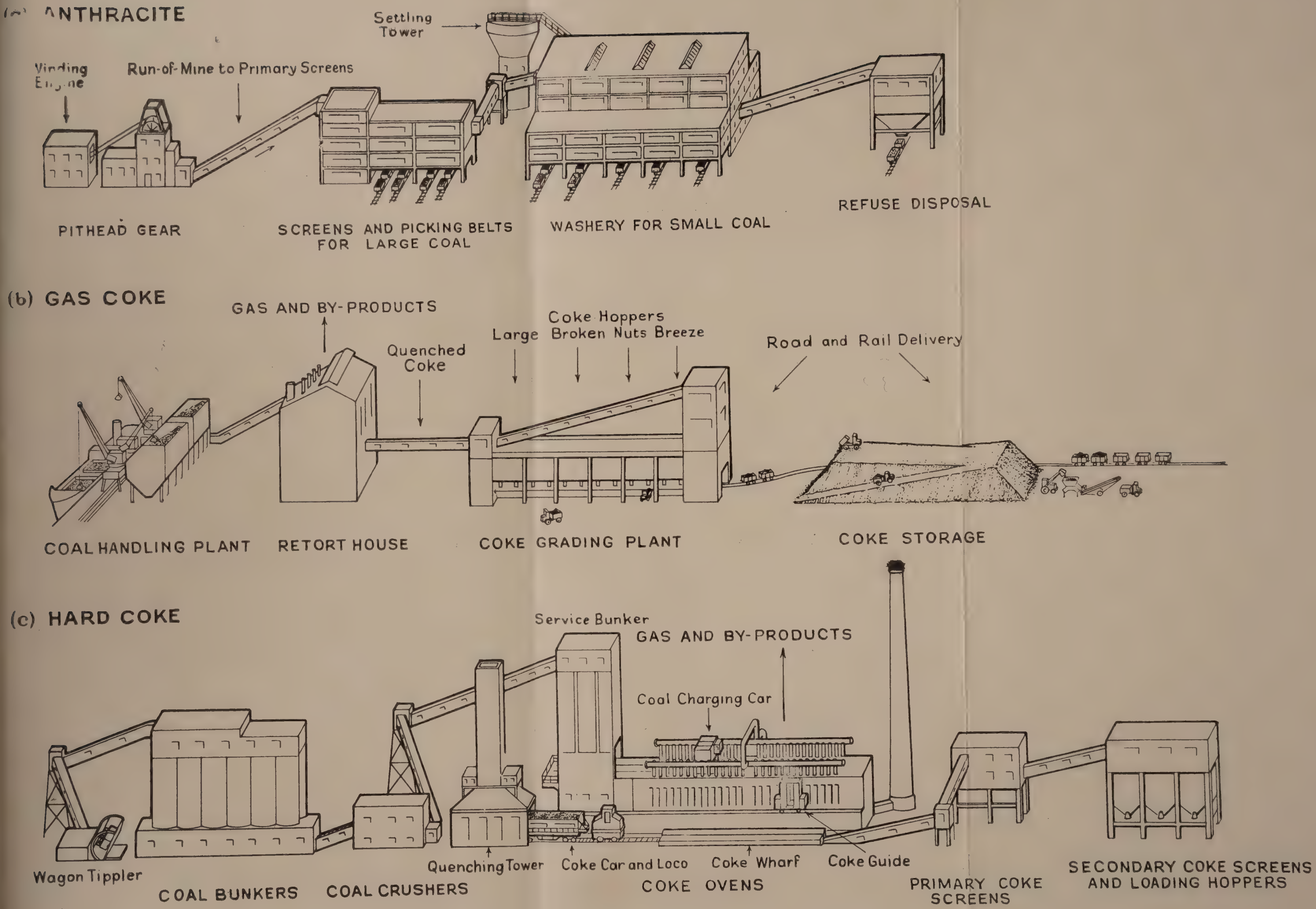

NTHRACITE
Settling Tower
Vinding
Run-of-Mine to Primary Screens
PITHEAD GEAR
SCREENS AND PICKING BELTS FOR LARGE COAL
WASHERY FOR SMALL COAL
REFUSE DISPOSAL
(b) GAS COKE
GAS AND BY-PRODUCTS
Quenched Coke
Coke Hoppers
Large Broken Nuts Breeze
Road and Rail Delivery
COAL HANDLING PLANT
RETORT HOUSE
COKE GRADING PLANT
COKE STORAGE
(c) HARD COKE
Service Bunker
GAS AND BY-PRODUCTS
Coal Charging Car
Wagon Tippler
COAL BUNKERS
COAL CRUSHERS
Quenching Tower
Coke Car and Loco
Coke Wharf
Coke Guide
COKE OVENS
PRIMARY COKE SCREENS
SECONDARY COKE SCREENS AND LOADING HOPPERS

Fig. 1

Fig. 2 (a)

, coal is fed is kept filled with a
kture of water and heavy medium
h as sand, barytes or magnetite in
-determined proportions. In this
y a separating medium having a
cific gravity between that of coal
l " dirt " is made in which the clean
l floats to the surface and the stone
ks to the bottom, the two products
ng removed continuously from the
tem.

After washing, the coal is first
sed over closely-set wedge-wire
eens for the removal of the washing
dium used in the separating bath.
hen passes on to a series of vibrating
eens which separate the coal into
sizes required for the market. In
dern installations the several pro-
ts are loaded into wagons over
loaders which are lowered into
wagons to prevent the breakage
ch would occur if the coal were
wed to drop from a height into
wagons. Immediately before load-
each product is sprayed with clean water which removes any remaining traces of adhering fines.

The fine material or dust is generally removed from the raw coal by screening before any washing takes place and is treated as a separate product. If clean enough it is loaded out for use as pulverized fuel in large boilers or it may be passed through a froth flotation plant specially designed to clean fine coal. In this process a froth is formed by passing air into a mixture of oil and water vigorously agitated by means of paddles. The froth attaches itself to the coal particles and lifts them to the surface of the tank while the " dirt " remains in the bottom—both being extracted separately.

Manufactured Fuels

The manufactured fuels, with the exception of " Phurnacite " which will be dealt with separately are products of the carbonization of bituminous coals. Their somewhat different properties are the result of the various

methods employed in their manufacture which although basically the same, vary considerably in detail.

Gas coke is the solid product of the high temperature carbonisation in retorts of relatively high volatile coals selected for their properties of giving a high gas yield and a physically strong coke.

Three types of retorts are commonly in use, known as horizontal, intermittent vertical, and continuous vertical retorts. Horizontal retorts are made in segments of silica, a material that can withstand high temperatures: they may be of either oval or "D"-shaped section, about 20 ft. long and hold about 16 cwts. of coal which is of a size below about 1¼ in. square mesh. Each end of the retort is closed by a metal door and each has an ascension pipe to carry off the gas, tar and ammonia to the purification system. At the conclusion of the carbonizing period of some 10 to 12 hours the doors are opened and the coke discharged on to a conveyor by means of a ram generally mounted on the coal charging machine. The coke is quenched with water in the conveyor. Horizontal retorts are commonly grouped in two vertical columns, each of which may contain three to five retorts. Such groups are known as " beds " and a bench comprises a number of " beds." Each " bed " has its own producer which is charged with hot coke and provides the producer gas which heats the retorts to the carbonizing temperature of about 1,000°C. To give some idea of size—a retort house of 200 retorts in two benches would carbonize 370 tons of coal per day, 260 tons of coke would be produced of which some 46 tons would be used in the producers.

Intermittent vertical retorts produce a coke similar in properties to horizontal retort coke. The retorts are, however, larger and the charge may be about 3½ tons. Further, being disposed vertically this type of plant is more economical of ground space. Before charging the retort with coal the discharging door is protected from excessive heat by a layer of breeze. The carbonizing period is some 10 to 12 hours at a temperature in the heating flues of about 1,000°C. at the top and 1,300°C. at the bottom. It is customary to steam the charge for the last two to three hours, thus increasing the yield of gas. When carbonization is complete the coke is discharged into a quenching car, the quenching being carried out under a quenching tower using a measured quantity of water.

Continuous vertical retort coke is of more open texture than either horizontal or intermittent vertical retort coke. It is thus lighter, it breaks more easily, but it is free-burning and on an open fire, for which it is particularly suitable, it gives plenty of flame. Coal feeds automatically into the top of the retort at the same rate as coke is extracted at the bottom and discharged into the coke box. To allow for the expansion of the coal on carbonization the retorts are tapered, being wider at the bottom. The capacity varies from about 3½ to 10 tons per retort per day. Steam or a water spray is admitted at the coke box and serves three purposes: firstly it cools the coke, secondly it keeps the extractor and bottom castings cool and thirdly it increases the gas yield by chemical reaction with the red hot coke which produced the combustible gases carbon monoxide and hydrogen (the mixture known as water gas). It is also probable that by this action of steam on coke its reactivity is increased.

The diagram Fig. 1(*b*) shows the general arrangement of plant from the point where coal arrives at the works to the storage of the coke after it has been separated into the commercial sizes.

Hard or Oven Coke

Hard or oven coke is always manufactured in coke ovens which consist basically of narrow rectangular chambers some 18 in. wide, 13 ft. high and 40 ft. long, disposed in batteries side by side with heating flues between adjacent ovens. Since coke is the main product of the Hard Coke

Industry some of the gas is used to heat the retorts and the balance is available for sale. The ovens are normally charged with coal through appropriate holes in the oven top and discharged by means of a ram after removing doors at each end of the oven. The red hot coke discharged by the ram passes through a guide and is received in a coke car which travels immediately to a quenching tower where the coke is quenched by means of water sprays, afterwards being spread along a sloping wharf where it is allowed to cool before it is taken by belt conveyor to a screening plant for separation into marketable sizes. Fig. 2(*b*) illustrates a modern battery of ovens from the discharge side to show the coke car and wharf.

The tall concrete tower on the left of the illustration is the coal service bunker. This stores the coal previously crushed to about 80 per cent. below $\frac{1}{8}$ in. square mesh before it is fed to the ovens. On the extreme right is the coke guide and door extractor which is moved to each oven before the coke charge is pushed. The diagram Fig. 1(*c*) illustrates the general arrangement of a typical coke oven plant.

Low Temperature Cokes

Low temperature cokes are produced either by the " Coalite " or the " Rexco " processes. The term " low temperature " as applied to this type of coke is sometimes taken to indicate that the temperature attained on burning is low in comparison with high temperature cokes. This is quite wrong and the term relates to the temperature of carbonization which is about 1,000°C. for the high and 600 to 650°C. for the low temperature processes respectively. The use of the lower temperature produces a free-burning coke which can replace bituminous coal in all domestic appliances.

In the " Coalite " process, which resembles in principle the high temperature process, the gas, tar, ammonia and benzole are collected and purified. The yield of gas is about 40 per cent. of that of the high temperature process and the yield of tar is roughly twice as great. Owing to its different composition, special

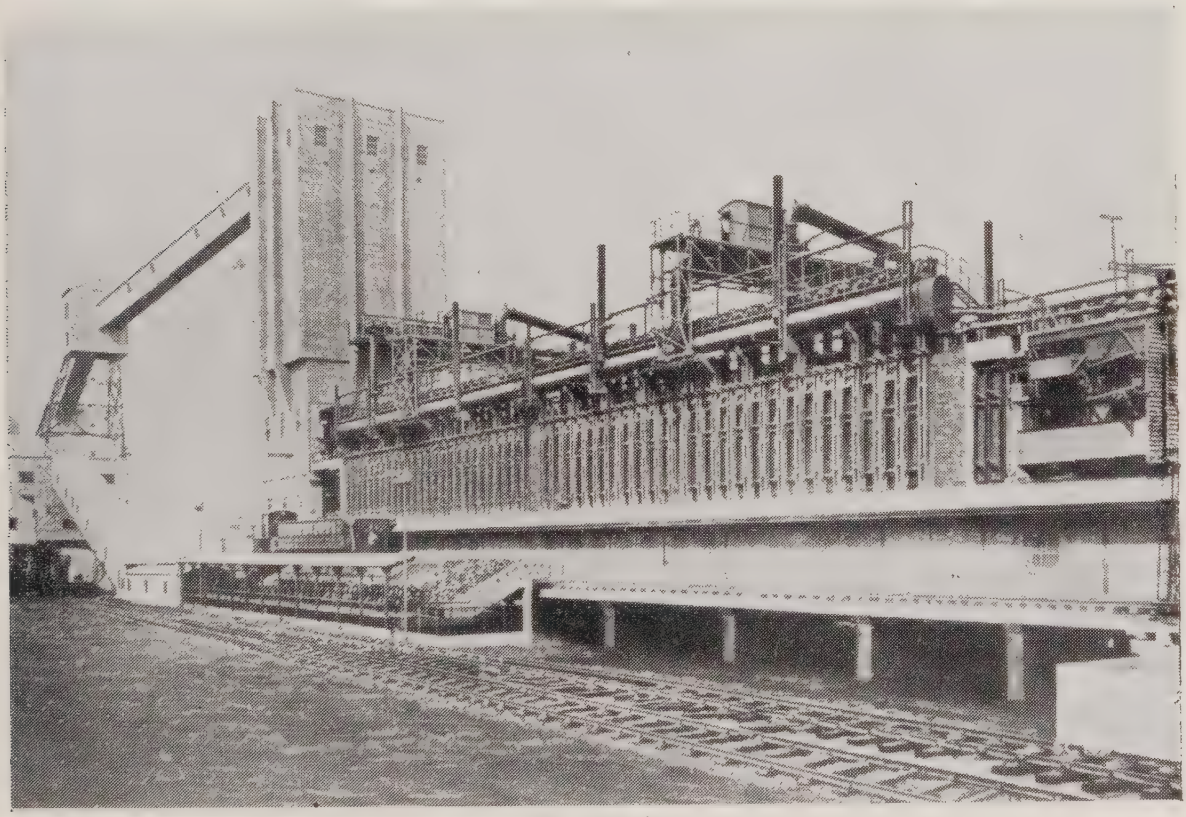


Fig. 2 (b)

TABLE 1

SIZES OF SOLID SMOKELESS FUELS

NATURAL SMOKELESS FUELS

Welsh Anthracite

Name	*Size Limits Round Mesh*
Large	Over 5″
Cobbles	3″—5″
French Nuts	2″—3″
Stove Nuts	$1\frac{1}{4}$″—2″
Stovesse	$\frac{7}{8}$″—$1\frac{5}{8}$″
Pea Nuts	$\frac{5}{8}$″—$1\frac{1}{4}$″
Beans	$\frac{3}{8}$″—$\frac{7}{8}$″
Peas	$\frac{3}{8}$″—$\frac{5}{8}$″
Grains	$\frac{3}{16}$″—$\frac{3}{8}$″
Washed Duff	0″—$\frac{3}{16}$″

Dry Steam Coal

Name	*Size Limits Round Mesh*
Large	Over 5″
Cobbles	$2\frac{1}{2}$″—5″
Large Nuts	$1\frac{3}{4}$″—$2\frac{1}{2}$″
Small Nuts	$\frac{3}{4}$″—$1\frac{3}{4}$″
Beans	$\frac{5}{8}$″—$\frac{3}{4}$″
Peas	$\frac{3}{8}$″—$\frac{5}{8}$″
Grains	$\frac{3}{16}$″—$\frac{3}{8}$″
Washed Small	0″—$\frac{3}{16}$″ to $\frac{3}{8}$″

MANUFACTURED SMOKELESS FUELS

Gas Coke

Size No.	*Square Mesh Screening within the limits of*
1. Large	Over $1\frac{3}{4}$″
1a. Large	$1\frac{3}{4}$″—$3\frac{1}{2}$″
2. Broken	1″—2″
3. Coke Boiler Nuts ..	$\frac{1}{2}$″—$1\frac{1}{4}$″
4. Forge Beans	$\frac{3}{8}$″—$\frac{3}{4}$″
5. Automatic Stoker Fuel	$\frac{1}{8}$″—$\frac{3}{4}$″
–. Coke Breeze	Under $\frac{5}{8}$″

Carbonized Ovoids

	Size Limits
“ Phurnacite ” ..	2″ x $1\frac{1}{2}$″ x 1″

Hard (Oven) Coke

Representative Sizes of Hard Coke

Square Mesh Screening within the limits of
Over $2\frac{1}{2}$″
$1\frac{1}{2}$″—$2\frac{1}{2}$″
1″—$1\frac{1}{2}$″
$\frac{3}{4}$″—$1\frac{1}{4}$″
$\frac{5}{8}$″—1″
$\frac{3}{8}$″—$\frac{5}{8}$″

Low Temperature Coke

	Size Limits
“ Coalite ”	Over $1\frac{1}{4}$″
Cooker “ Coalite ” ..	$\frac{3}{4}$″—$1\frac{1}{2}$″
“ Coalite ” Peas	$\frac{3}{8}$″—$\frac{3}{4}$″
“ Rexco ”	Over $1\frac{3}{4}$″
“ Rexco ”	$\frac{3}{4}$″—$1\frac{3}{4}$″
“ Rexco ”	$\frac{3}{8}$″—$\frac{3}{4}$″

refinery technique has been developed and the production of indigenous diesel oil from the tar is an important feature. The retorts in the " Coalite " process are made of a special heat-resisting cast iron and are heated by some of the gas produced in the process. Each retort consists of a nest of 12 tubes increasing in diameter from $4\frac{1}{2}$ in. at the top to $5\frac{3}{4}$ in. at the bottom. The coal is charged and the semi-coke discharged intermittently, the carbonizing period being four hours. There is a cooling chamber below each retort where the semi-coke remains for a further four hours before it is sized for the market.

" Rexco "

The large, vertical, cylindrical retorts, in which " Rexco " is produced, are charged from the top with about 34 tons of coal from which the fines and dust have been removed. The coal is ignited at the top and the hot gases are circulated through the charge for nine hours. Thus carbonization is carried out by the gas from the coal itself. At the conclusion of the carbonizing period the " Rexco " is cooled by circulating gas. It is then discharged and screened into the sizes given in Table 1. A feature of " Rexco " is its low moisture content which is not more than 5 per cent. From each 100 tons of coal, 72 tons of " Rexco " are produced as well as 20 gallons of tar-oil and 30 therms of surplus gas.

" Phurnacite "

" Phurnacite " is at present prepared from specially selected Welsh Dry Steam small coals which are first cleaned and then briquetted into ovoids using pitch as the binder. The ovoids are then heated in a retort so that the volatile constituents are driven off, the latter being used to provide the heat necessary to the process.

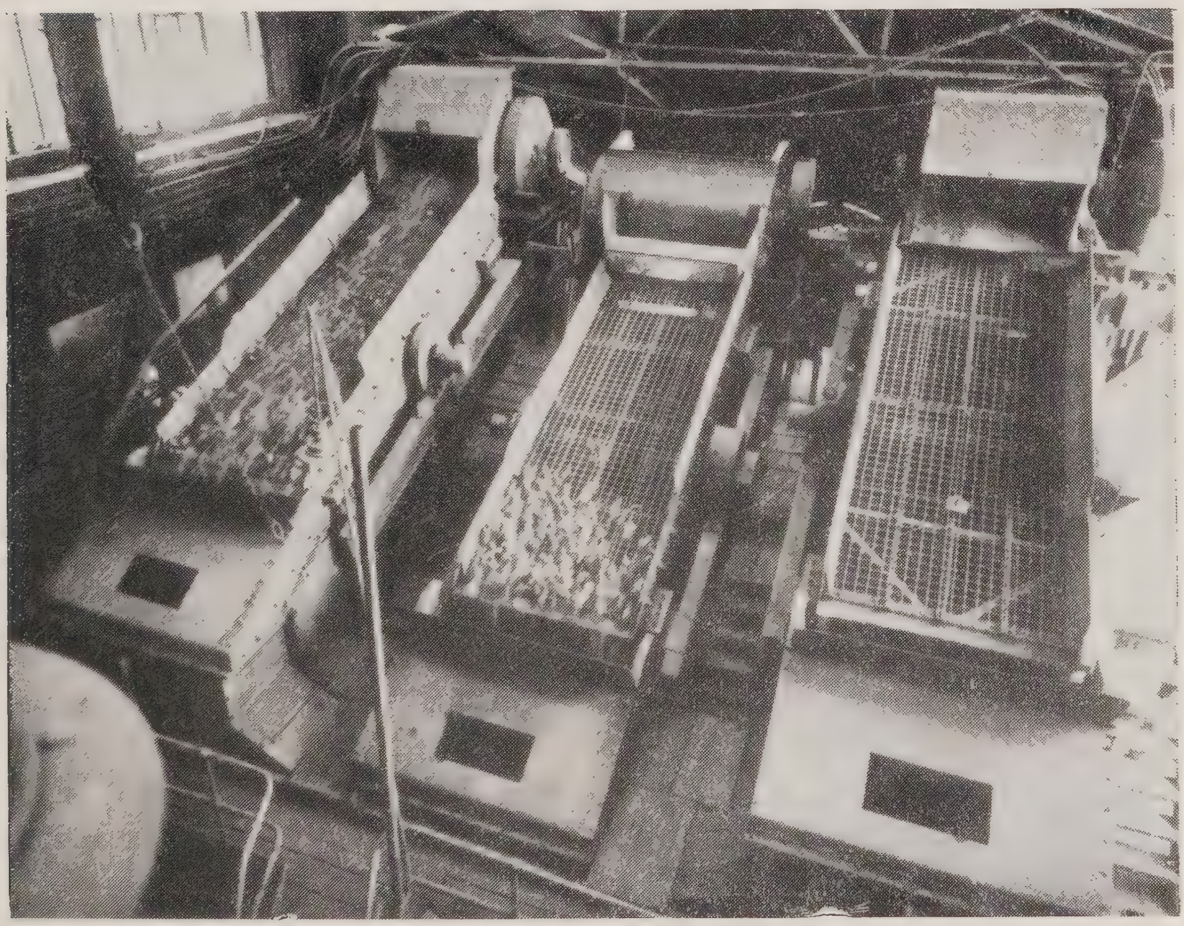


Fig. 2 (c)

This is essentially a carbonizing process hence the general name "carbonized ovoids," of which "Phurnacite" is an example. It should be noted that the choice of coals and temperature of heating ensure that the ovoids retain their shape and that no sizing is necessary with this fuel. The ovoids measure approximately $1\frac{3}{4}$ by $1\frac{1}{4}$ in. and each weighs roughly one ounce.

Preparation for the Market

Preparation for the market of all the solid smokeless fuels other than "Phurnacite" involves their separation into size grades. Similar types of screening plant are used by all the solid smokeless fuel industries. They consist often of either a reciprocating or a high speed vibrating frame supporting cloths of perforated plate or woven wire. The screen apertures are generally round or square and regular tests are made to ensure that the screen cloth is changed when it becomes too worn for correct sizing. Fig. 2(*c*) illustrates a typical type of screen and Table 1 gives the sizes of solid smokeless fuels now produced.

Storage

From the screens the various sizes of fuel are discharged either into buffer hoppers or direct into road or rail vehicles. In the Gas Industry special problems arise and storage has to be provided for coke produced in summer, but not required by the user until the winter. Owing to the gradual shift in gas coke markets from industrial to domestic, in which the ratio of winter to summer demand may be as high as $6\frac{1}{2} : 1$, increased summer storage is needed. Fig. 1 (*b*) shows one way in which this is being met. This is known as the double ramp system, the heap of sized coke some 30 to 35 ft. high is built up as shown in the illustration. Coke is recovered from the heap using mechanical shovels and a mobile bagging and debreezing machine. With this equipment the sizing of the coke from the storage heap can be as satisfactory as that from hoppers.

PART 2—THE UTILIZATION OF SOLID SMOKELESS FUELS

Solid Smokeless Fuels and the National Interest

The utilization of solid smokeless fuels is part of the general subject of the efficient use of fuel. This is of national importance and is a very wide and increasingly important matter. It is wide since it embraces not only the properties of fuels, which govern their combustion, but also the design, installation and application of the appliances in which they are used. It is increasingly important since the supplies of our indigenous fuels are becoming year by year less able to meet the increasing demands of modern industry and at the same time provide the improved amenities and comfort standards now advocated for our homes. Our fuels have therefore to be used at maximum efficiency and to the best possible advantage. The urgency of this is clearly recognized and all will be familiar with the recommendations of the reports of the Government Committees, the Simon Report issued in 1946 and the Ridley Report issued only six years later, in 1952. In the technique of utilization, fuel technologists have designed new appliances and much time has been spent on providing the fuel user with information and advice with the result that we are all more fuel conscious. A good start was made during the war when the Fuel Efficiency Committee of the Ministry of Fuel and Power prepared and issued 51 Fuel Efficiency Bulletins, covering in detail all aspects of fuel usage. Two text books were subsequently issued by H.M. Stationery Office at a price within the reach of all. These were *The Efficient Use of Fuel*, compiled by a number of contributors and *The Efficient Use of Steam*, written by Oliver Lyle. There is also Post War Building Study No. 19, better known as the Egerton Report. Further official publications have been issued as Codes of Practice and as British Standards by the British

Standards Institution. These cover most aspects of domestic, central heating and industrial fuel utilization. The fuel producers have continued and extended their advisory services. For example, the members of the Solid Smokeless Fuels Federation individually and collectively issue technical booklets, arrange exhibitions and provide a free technical service. A similar but much more extensive service is provided by the Coal Utilization Council who have expanded their work considerably in recent years by opening Regional Offices and by introducing their Agency Scheme for retailers of approved appliances. Mention must also be made of the work of the Women's Advisory Council for Solid Fuel whose particular interest is the education of women in solid fuel matters. To complete the picture, reference must be made to the advice given by the appliance makers to whom very often the first approach is made and who all provide full installation and operating instructions for their products. All the above organizations and individuals are working to the same end, namely, to educate and help the public to use fuel more effectively and it will be clear that the effort and time spent is considerable. There can be no doubt that this effort is beneficial but so far as fuel consumption statistics are concerned little or no improvement can be noted. It is probable that improved efficiency has to some extent been counter-balanced by the increased demands of industry, but there is ample evidence that much can still be done to stop fuel waste, with the domestic user and particularly with the small industrial user, where the size of the unit does not justify the expense of a fuel engineer. The direction in which fuel savings can be made is clearly recognized, but there is little or no information on the extent of savings possible.

In considering this national fuel problem, the authors are convinced and would stress that the establishment of smokeless zones, with which the National Smoke Abatement Society is clearly identified, provides an excellent opportunity for obtaining information at once reliable and of national importance. In areas where a smokeless zone is projected, a census is generally made of all appliances, inefficient smoke-producing appliances have to be improved or replaced, and certainly all old-fashioned domestic appliances have to be renewed and this provides the opportunity of introducing modern equipment, correctly installed, which should save fuel. The question to be answered is how much will be saved?

As a contribution to this subject the authors decided it would be helpful to deal with the utilization of solid smokeless fuels from the standpoint of smokeless zones.

Fuel Sizes

Solid smokeless fuels are used for all purposes: domestic, central heating, steam-raising, drying, furnace-heating, etc. For each use there is a recommended size and generally a choice of alternative fuels. Tables 2 and 3 give this information for domestic appliances and for central heating, horticultural and small steam-raising boilers respectively.

Domestic Appliances

The open fire appliance either in the form of an inset open fire or as a combination grate is installed in practically all the living rooms of this country. A Social Survey (2) carried out in 1948/49 gives the figures as 98 per cent. and a more recent Survey (3) organized by the Coal Utilization Council confirms this by finding 67 per cent. open fires, 24 per cent. ranges or cookers and 9 per cent. others in a sample of some 2,050 households covering a wide range of income groups. Dr. Parker (4) has reported that open fires account for a pollution of 0.9 million tons of smoke per annum or about one half of the total from all uses. In spite of all the recent advances in the design of domestic appliances the stage has not yet been reached where it is possible to burn bituminous coal

TABLE 2

RECOMMENDED SIZES OF SOLID SMOKELESS FUELS FOR DOMESTIC APPLIANCES

	Gas Coke	*Hard Coke*	*Anthracite*	*Welsh Dry Steam Coal*	*Carbonized Ovoids*	*Low Temperature Coke*
Open Fires—Modern Types inc. Convector fires fitted with bar grates	No. 2 Open Fire Coke (1"—2")	$1''$—$1\frac{1}{2}''$ $\frac{3}{4}''$—$1\frac{1}{4}''$	French Nuts 2"—3" Stove Nuts $1\frac{1}{4}''$—2"	Large Nuts— $1\frac{3}{4}''$—$2\frac{1}{2}''$ Small Nuts— $\frac{3}{4}''$—$1\frac{3}{4}''$	" Phurnacite "	" Coalite " " Rexco " over $1\frac{3}{4}''$
Stoves (*a*) Closed hopper feed (*b*) Open—Closed	No. 3 Boiler Nuts ($\frac{1}{2}''$—$1\frac{1}{4}''$) No. 2 Broken (1"—2")	$\frac{3}{4}''$—$1\frac{1}{4}''$ $\frac{5}{8}''$—1" 1"—$1\frac{1}{2}''$	(*a*) Stovesse $\frac{3}{4}''$—$1\frac{3}{8}''$ Beans $\frac{3}{8}''$—$\frac{3}{4}''$ (*b*) French Nuts 2"—3" Stove Nuts $1\frac{1}{4}''$—2"	(*b*) only Large Nuts $1\frac{3}{4}''$—$2\frac{1}{2}''$ Small Nuts $\frac{3}{4}''$—$1\frac{3}{4}''$	(*a*) and (*b*) " Phurnacite "	(*a*) " Coalite " $\frac{3}{4}''$—$\frac{1}{2}''$ (*b*) " Coalite " $\frac{3}{4}''$—$1\frac{1}{2}''$ (*a*) " Rexco " $\frac{3}{8}''$—$\frac{3}{4}''$ (*b*) " Rexco " over $1\frac{3}{4}''$ " Rexco " $\frac{3}{4}''$—$1\frac{3}{4}''$
Small Domestic Boilers	No. 3 Boiler Nuts ($\frac{1}{2}''$—$1\frac{1}{4}''$)	$\frac{5}{8}''$—1"	Stove Nuts $1\frac{1}{4}''$—2" Pea Nuts $\frac{5}{8}''$—$1\frac{1}{4}''$	Small Nuts $\frac{3}{4}''$—$1\frac{3}{4}''$	" Phurnacite "	" Coalite " $\frac{3}{4}''$—$1\frac{1}{2}''$ " Rexco " $\frac{3}{4}''$—$1\frac{3}{4}''$
Large Domestic Boilers Small Central Heating Boilers 50,000 to 150,000 B.Th.U. per hr.	No. 2 Broken (1"—2")	$1\frac{1}{2}''$—$2\frac{1}{2}''$ 1"—$1\frac{1}{2}''$	French Nuts 2"—3" Stove Nuts $1\frac{1}{4}''$—2"	Large Nuts $1\frac{3}{4}''$—$2\frac{1}{2}''$ Small Nuts $\frac{3}{4}''$—$1\frac{3}{4}''$		" Coalite " " Rexco " over $1\frac{3}{4}''$
Cooker, Freestanding (*a*) Heat Storage (*b*) Heat Insulated	(*a*) and (*b*) No. 3 Boiler Nuts ($\frac{1}{2}''$—$1\frac{1}{4}''$) Some (*b*) use No. 2 (1"—2")	$\frac{3}{4}''$—$1\frac{1}{4}''$ $\frac{5}{8}''$—1"	(*a*) and (*b*) Stovesse $\frac{3}{4}''$—$1\frac{3}{8}''$ Pea Nuts $\frac{5}{8}''$—$1\frac{1}{4}''$ Stove Nuts $1\frac{3}{8}''$—2" (*b*) only	(*b*) only Large Nuts $1\frac{3}{4}''$—$2\frac{1}{2}''$ Small Nuts $\frac{3}{4}''$—$1\frac{3}{4}''$	(*a*) and (*b*) " Phurnacite "	(*a*) and (*b*) " Coalite " $\frac{3}{4}''$—$1\frac{1}{2}''$ (*a*) " Rexco " $\frac{3}{4}''$—$1\frac{3}{4}''$ (*b*) " Rexco " $\frac{3}{8}''$—$\frac{3}{4}''$
Combination Grates	No. 2 Broken (1"—2")	1"—$1\frac{1}{2}''$	French Nuts 2"—3" Stove Nuts $1\frac{3}{4}''$—2"	Large Nuts $1\frac{3}{4}''$—$2\frac{1}{2}''$ Small Nuts $\frac{3}{4}''$—$1\frac{3}{4}''$	" Phurnacite "	" Coalite " " Rexco " over $1\frac{3}{4}''$

TABLE 3

RECOMMENDED FUEL SIZES FOR TYPICAL LARGE CENTRAL HEATING, HORTICULTURAL AND SMALL STEAM BOILER INSTALLATIONS

Appliance	*Anthracite*	*Welsh Dry Steam Coal*	*Gas Coke*	*Hard Coke*
LARGE CENTRAL HEATING AND HORTICULTURAL BOILERS				
(*a*) Hand-fired under 300,000 B.Th.U. per hr.	French Nuts 2″—3″	Large Nuts $1\frac{3}{4}$″—$2\frac{1}{2}$″	No. 2 Broken 1″—2″	$1\frac{1}{2}$″—$2\frac{1}{2}$″
Hand-fired over 300,000 B.Th.U. per hr.	Cobbles 3″—5″	Cobbles $2\frac{1}{2}$″—5″	No. 1 Large over $1\frac{3}{4}$″	over $2\frac{1}{2}$″
(*b*) Hand-fired with Pre-burner Unit	Beans $\frac{3}{8}$″—$\frac{7}{8}$″ Peas $\frac{3}{8}$″—$\frac{5}{8}$″	Beans $\frac{5}{8}$″—$\frac{3}{4}$″ Peas $\frac{3}{8}$″—$\frac{5}{8}$″	No. 3 $\frac{1}{2}$″—$1\frac{1}{4}$″ No. 2 1″—2″	$\frac{3}{8}$″—$\frac{3}{4}$″
(*c*) Automatic Boilers (Hopper Feed)	Beans $\frac{3}{8}$″—$\frac{7}{8}$″ Peas $\frac{3}{8}$″—$\frac{5}{8}$″	Beans $\frac{5}{8}$″—$\frac{3}{4}$″ Peas $\frac{3}{8}$″—$\frac{5}{8}$″	No. 4 Forge Beans $\frac{3}{8}$″—$\frac{3}{4}$″ No. 3 Boiler Nuts $1\frac{1}{2}$″—$1\frac{1}{4}$″	$\frac{3}{8}$″—$\frac{3}{4}$″ $\frac{3}{4}$″—$1\frac{1}{2}$″
(*d*) Gravity Feed Boilers (Magazine)	Stove Nuts $1\frac{1}{4}$″—2″	Small Nuts $\frac{3}{4}$″—$1\frac{3}{4}$″	No. 2 Broken 1″—2″	$\frac{3}{4}$″—$1\frac{1}{2}$″
SMALL STEAM BOILERS				
(*a*) Low Pressure Sectional Type	As for large Central Heating Boilers			
(*b*) Vertical Hand-fired Small	French Nuts 2″—3″	Large Nuts $1\frac{3}{4}$″—$2\frac{1}{2}$″	No. 2 Broken 1″—2″	$1\frac{1}{2}$″—$2\frac{1}{2}$″
Vertical Hand-fired Large	Cobbles 3″—5″	Cobbles $2\frac{1}{2}$″—5″	No. 1 Large over $1\frac{3}{4}$″	over $2\frac{1}{2}$″
(*c*) Shell Type	French Nuts 2″—3″ Cobbles 3″—5″	Large Nuts $1\frac{3}{4}$″—$2\frac{1}{2}$″ Cobbles $2\frac{1}{2}$″—5″	No. 1 Large over $1\frac{3}{4}$″	over $2\frac{1}{2}$″
(*d*) Stoker-fired Boilers (Screw Feed)	Not recommended	Peas and Duff mixed 0″—$\frac{5}{8}$″	Not recommended	not recommended

smokelessly in an open fire appliance and smokelessness can only be achieved by the use of smokeless fuels.

While all solid smokeless fuels may be burned on open fire appliances, availability generally limits the choice to gas coke, Welsh Dry Steam coal or the low temperature cokes "Coalite" or "Rexco." To ensure the correct quality, the gas coke sold for open fires has to be selected both as regards size and combustibility, and the name "open fire coke" is used in some parts of the country for purposes of identification. Hard coke can be suitably prepared for the open fire and in all exhibitions arranged by the Federation it is burned in rotation with other solid smokeless fuels. Generally, however, hard coke is not sold in this market. This is also true for Anthracite, although in South Wales many householders choose it in preference to other fuels.

The appliance now known as the improved open fire is necessary for burning Anthracite, gas and hard cokes; all the other fuels can be burned on the more widespread coal-burning appliances. Thus, without alteration of appliances the use of "Coalite," "Rexco," or Welsh Dry Steam coal will eliminate smoke. It is now appropriate to consider what are the advantages of the newer appliances and what would be the cost of installing them. From the national standpoint the newer appliances ensure a wider selection of fuels and whenever a simple stool bottom grate is replaced either by an improved open fire with back boiler, a convector open fire or a convector open fire with back boiler, there is a considerable improvement in efficiency; up to twice as high for the first two types of appliance and to about $2\frac{1}{2}$ times for the last type. The improvement in efficiency of the improved open fire without boiler or convection over the stool bottom grate has been questioned by a number of investigators recently who have shown by laboratory tests that when burning bituminous coal there is no increase in efficiency by changing to the improved open fire. It has been proved, however, that with smokeless fuels efficiency is improved and that the closer control of combustion with the newer grates can lead to fuel saving. Fig. 3 illustrates the control of combustion

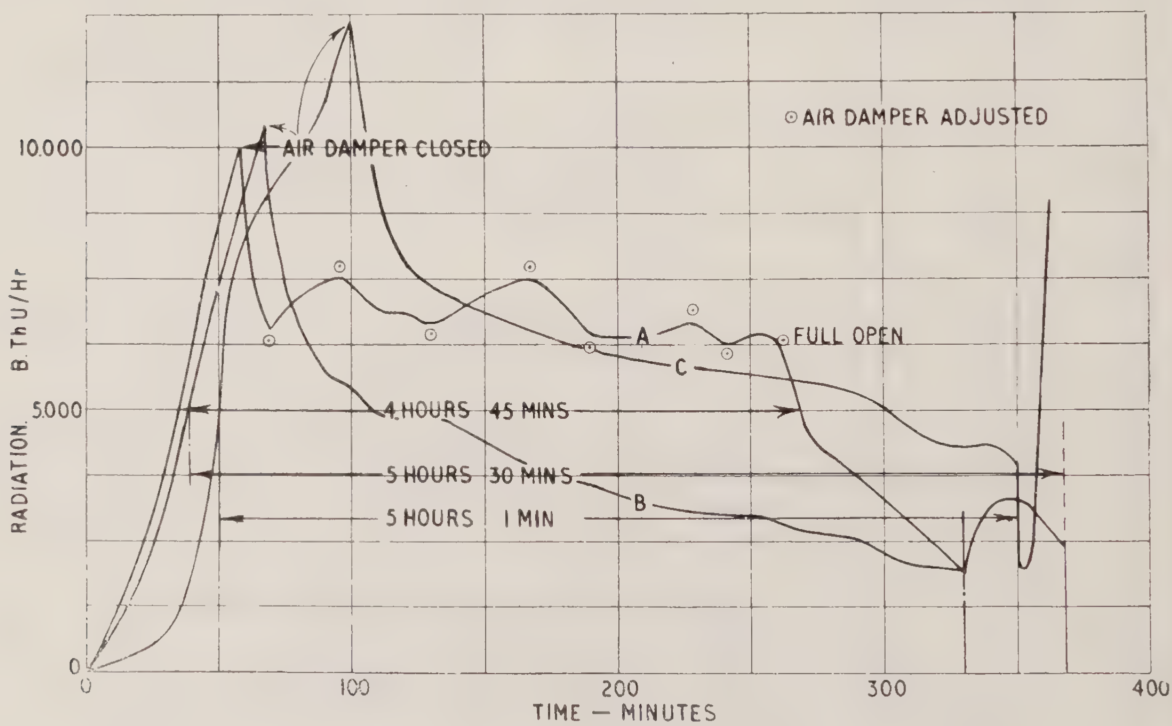


Fig. 3. Combustion control obtained with Fulham Open Fire
Curves A and B—Coke; Curve C—Coal

with both bituminous coal and coke obtainable with the improved open fire. The British householder likes the new fires and has shown appreciation in a most convincing way by purchasing some $2\frac{1}{4}$ million fires in the year 1952. There can be no doubt, however, that if substantial savings in domestic fuel consumption are to be effected, the appliance chosen for the living room should include convection or should incorporate a large back boiler. Examples of these appliances are given in Fig 5 (*c*) and 5 (*d*).

The openable stove, examples given in Fig. 4 (*a*) and 4 (*b*), provides heating by convection as well as radiation and is most suitable when minimum fire attention is required for long periods. Very high efficiencies are obtained from these appliances especially when a back boiler is incorporated. Normally these appliances operate with the doors closed when the greater proportion of the output is in the form of convection, but the radiation can be increased by opening the front doors so as to form what is virtually an open convector fire. The fire is cleaned by means of an internal grate-shaking device which prevents the emission of fly-ash into the room. It is unfortunate that the higher capital cost has prevented the openable stove supplanting the use of open fires. Many consider the additional expense justified on account of convenience and improved heating.

The independent open fire, Fig. 4 (*d*), is in prototype form but tests indicate that the efficiency will be as high as that of a convector fire. This appliance has not yet been costed by the makers but it is anticipated that the complete installation will be cheaper than the convector fire.

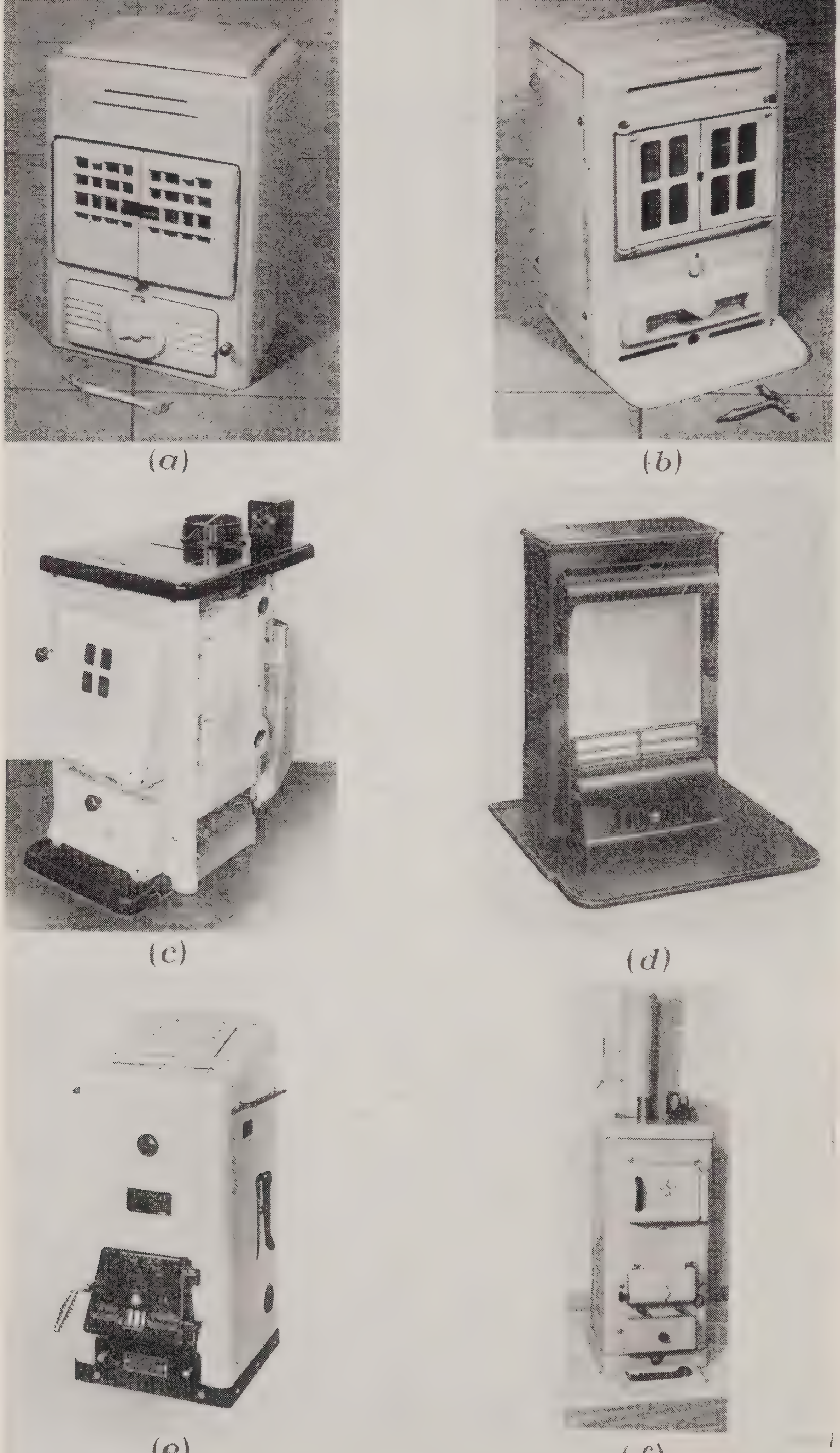
An improvement in the useful efficiency of non-convector appliances can be effected by the use of chimney ventilation control. The appliances (*e*) and (*f*) illustrated in Fig. 5 have such a control incorporated in them; this is desirable since the control device can be suited to the appliance so that under all conditions of firing and with all types of fuel the flue will clear the products of combustion. The control in appliance (*e*) takes the form of an adjustable damper placed across the entrance to the chimney, whilst in appliance (*f*) an adjustable canopy is provided and this can also be removed when access to the chimney is necessary. Appliance (*f*) also has the advantage of a flatter slope on the fireback, thus directing heat from the fire towards the hearth. Experiments have shown that chimney ventilation control can halve the air change through the room and the draughts associated with the open fire are considerably reduced with a marked increase in comfort. There is a possibility of fuel saving by this means, although many consider that the main result will be a higher level of comfort for the same fuel consumption. As in so many other fields of fuel usage, there are at present no data to indicate the fuel saving effected by chimney ventilation control or indeed by the installation of higher efficiency appliances. Such data are urgently needed to act as a guide to the direction in which fuel savings can best be effected and perhaps as important, the cost to the country of such savings.

Cost of Installing Open Fire Appliances

The cost of purchase and installation of the new appliances is all important and on this factor alone often depends the fate of an improvement scheme. Naturally the cost varies with the appliance and the extent of the alterations, for example, if a piped hot water service is to be included. The following examples of schemes known to the authors are given as a guide to costs of conversion.

Example 1 (London)

Fig. 6 illustrates a conversion now being carried out by a Local Authority in flats erected in 1932. The conversion comprises taking out the original Yorkshire range, bricking-in the vacant recess, facing with tiles and installing an improved open fire with back boiler set and running a service



(a) (b) (c) (d) (e) (f)

Fig. 4

for the gas ignition burner. Carried out in groups of ten this replacement costs £35 per appliance.

Example 2 (London)

Supplying and fixing improved open fire in existing fireback and connecting to gas point adjacent to fire £4 15s. to £5 10s., according to the make of fire selected.

Example 3 (Wales)

Supplying and fixing improved open fire in existing fire place with back boiler and in some cases raising the boiler to the correct position (i.e., top of boiler flue 3 inches above the top of the bottom firebars) average cost for 1,400 conversions £7 per installation.

Example 4 (Wales)

Removing existing cooker, making good, installing modern combination grate, running water connection from back boiler. Average cost for 680 conversions, £70 each.

Example 5 (Birmingham)

Take out combination grate, cement render brick face of existing recess, provide slab over, install free-standing space heating stove with flue adaptor sealed to flue lintel, provide and lay slabbed tile hearth.

	£	s.	d.
Builders' work ..	16	10	0
P.C. sum for stove ..	17	10	0
Total	34	0	0

Example 6 (Birmingham)

All as for Example 5, but including for stove with boiler.

	£	s.	d.
Builders' work ..	22	0	0
P.C. sum for stove ..	24	0	0
Total	46	0	0

Fig. 4 (*Opposite*)

(*a*) *Yorkray Heating Stove.*
(*b*) *Torglow Heating Stove.*
(*c*) *Tayco Boiler with thermostat*
(*d*) *An Independent Open Fire.*
(*e*) *Trianco Magazine Boiler.*
(*f*) *Beeston Royal Automatic Boiler.*

Example 7 (Birmingham)

Take out combination grate, install one-piece fireback with approved inset grate, provide and fix housing type tile surround and hearth. Brick up opening and make good plastering.

	£	s.	d.
Builders' work ..	22	10	0
P.C. sum for grate ..	5	10	0
Total	28	0	0

Example 8 (Birmingham)

All as Example 7, but including approved boiler flue set and grate.

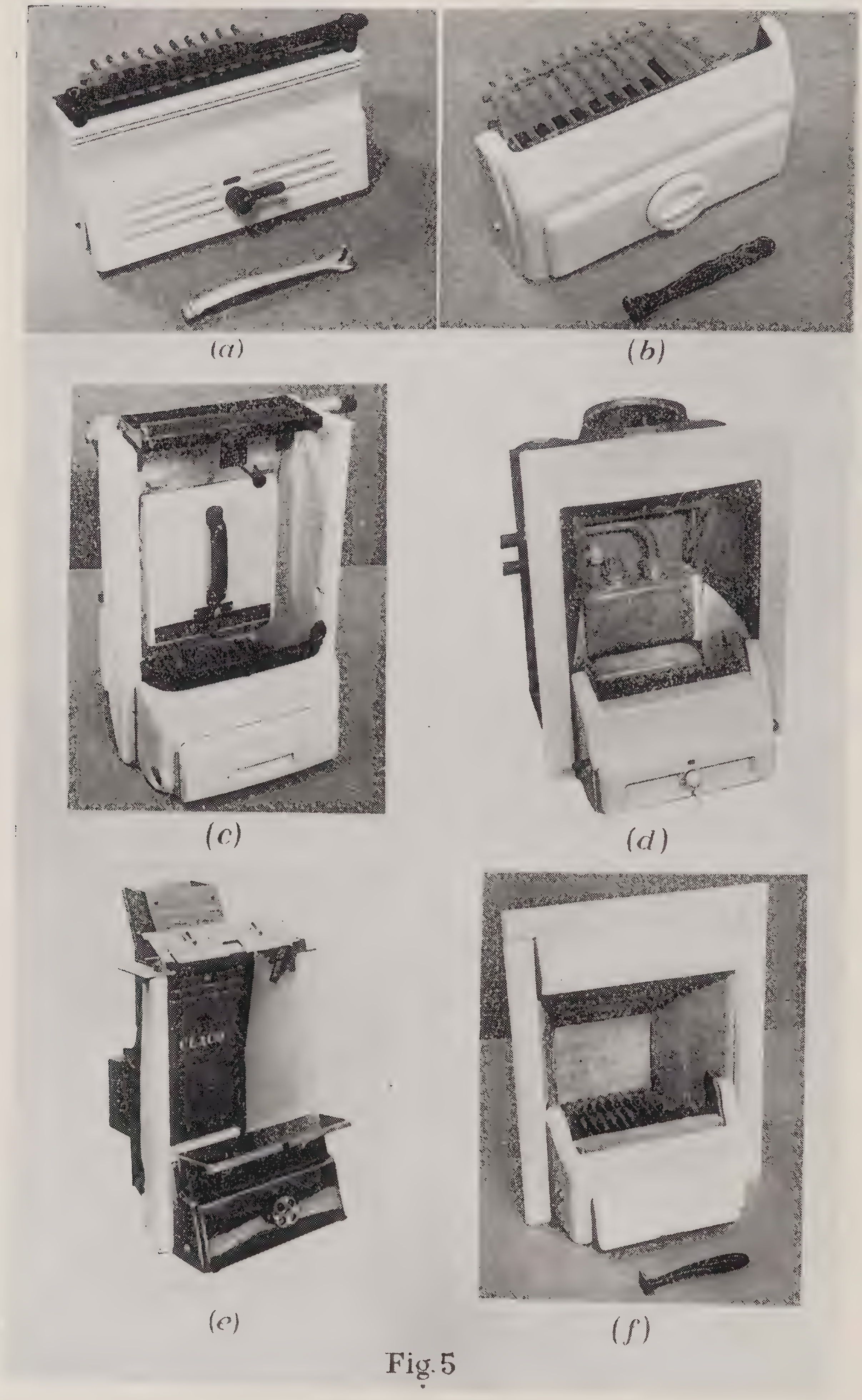
	£	s.	d.
Builders' work ..	32	10	0
P.C. sum for grate ..	5	10	0
Total	38	0	0

The authors would be most interested to learn how these costs compare with those of similar conversions carried out elsewhere.

Office Heating

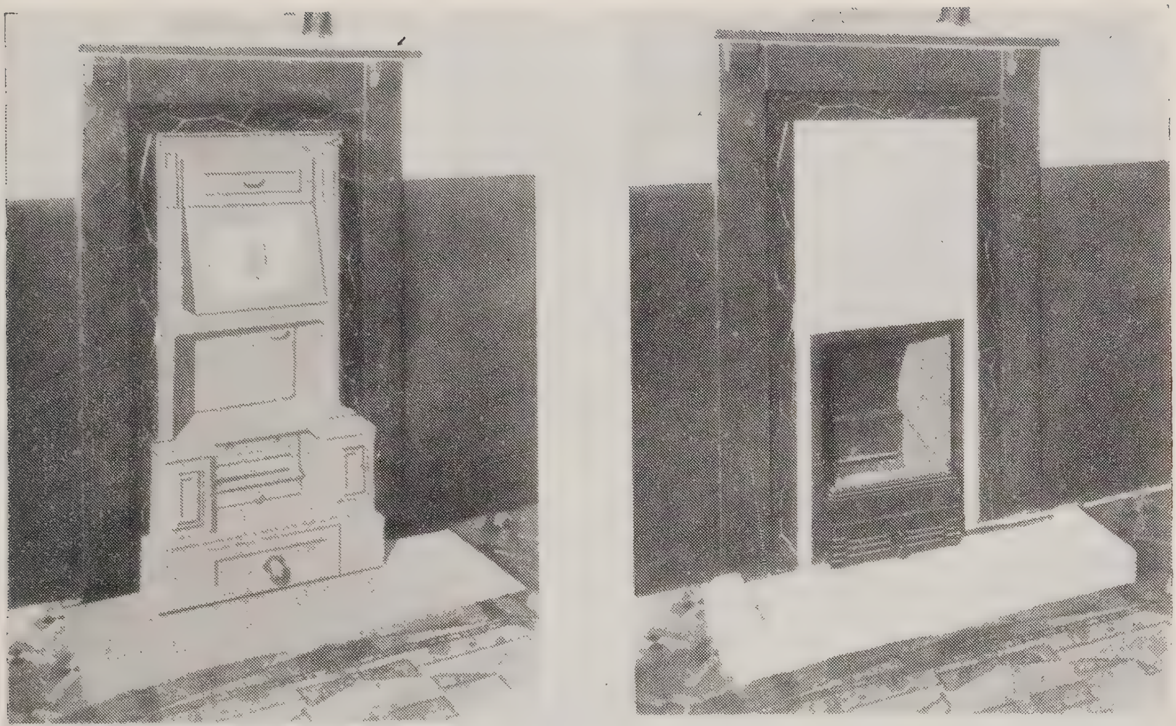
(i) *The one to three room office*

In most towns and particularly in areas where smokeless zones are most likely to be established, there are generally blocks of offices comprising suites of one to three rooms often heated by open coal fires. For these the openable stove burning any of the fuels recommended in Table 2 will be found an attractive proposition. There is no need for chimney sweeping, the heat output can be simply controlled and overnight burning may be used with safety when required. The heating stove is traditionally an Anthracite stove and the slow burning and high bulk density characteristics of Anthracite make it a good choice for this appliance. Although the free-standing models are generally some £3 to £4 more expensive than inset models, the former are generally cheaper to fix and the final cost of the installation of both types can be roughly the same Fig. 4 (*a*) and (*b*) are examples of modern free-standing openable stoves and for office heating they would normally be used closed. When in-



(a) (b) (c) (d) (e) (f)

Fig. 5



(a) Before conversion. *(b) After conversion.*

Fig. 6

stalling these appliances it should be remembered that the fire precaution regulations require a distance of at least 12 inches from the appliance to the edge of the hearth which should have a curb 2 inches high and not more than 4 inches wide. These requirements are given in Code of Practice 403, 1952 Open Fires, Heating Stoves and Cookers burning Solid Fuels to which reference should be made for correct methods of installation.

(ii) *The heating of Larger Offices, Shops, Banks, etc.*

When space heating has to be provided to more than three rooms, central heating by radiators or warm air heating is more convenient in that there is only one appliance and in general this can be operated at a higher level of efficiency. Practically all the wide range of boilers and furnaces suitable for this market are designed specially for solid smokeless fuels and this is particularly so for the automatic hopper or magazine type of boiler where the non-swelling property and close sizing of the fuel are essential. Table 2 gives the sizes of solid smokeless fuels suitable for these boilers. The modern tendency is to include thermostatic control with the boiler and this is included with the three examples (*c*), (*e*) and (*f*) illustrated in Fig. 4.

Space heating by means of radiators is regarded by many as an expensive method, and there can be no doubt that as installed and used in this country much of the useful heat generated by the boiler at high efficiency is wasted. This waste results from excessive ventilation and from overheating. Few people realize the extent of the waste which can take place from these two causes. In countries where central heating is the

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Fig. 5 (*Opposite*)

(*a*) *London.*
(*b*) *Redfyre* 55.
(*c*) *Fulham Fin-bac Boiler with Newbold open fire.*
(*d*) *Sofono Convector with back boiler.*
(*e*) *Claco large back boiler unit with flue restrictor damper.*
(*f*) *Calesto Open Fire incorporating flue restrictor canopy.*

rule rather than the exception very great care is taken to have the windows and doors tight fitting and in all hotels notices are prominent warning people to keep the windows shut. In addition thermostatic control is widely adopted. Thus, when installing central heating, all windows and doors should be weather-stripped and some form of thermostat used so that the room temperature can be controlled at the desired comfort level when the building is occupied and at a considerably lower temperature at other times. It should be realised that the heat loss from a building is proportional to the temperature difference across the boundary surfaces, thus, if the outside air temperature is 40°F. and the building is maintained at 65°F. at some time and at 70°F. at another, the higher temperature will result in a 20 per cent. increase in fuel consumption.

Larger Boilers for Central Heating and for Steam Raising

In this field of fuel utilization the majority of boilers under a rated output of about 750,000 B.Th.U./hour are hand-fired and for such boilers solid smokeless fuels must be used to ensure no smoke pollution. The types and sizes of fuels recommended for different types of boilers are given in Table 3. Under present price conditions there is little advantage apart from convenience by installing automatic firing for boilers below the 750,000 B.Th.U./hour rating. There is, however, generally a fuel saving when the boiler is fired automatically due largely to the automatic control of combustion which is an essential part of the equipment. The performance of a hand-fired installation can be much improved by use of thermostatic control and this should be fitted to all boilers.

For larger boilers automatic firing is generally desirable and most new installations are now so equipped. The most common type of equipment is the underfeed stoker. Such plant is most commonly fired with bituminous coal. Of the solid smokeless fuels Welsh Dry Steam coal beans or peas are recommended. Gas coke and hard coke are generally too abrasive and cause more rapid wear of the feed tube even when this is of the modern "low wear" type in which arrangements are made that the feed tube is never more than about two-thirds full. Cokes can be and are burned on underfeed stokers, but the following advice given in a recent book published by the Combustion Engineering Association[6] should be noted. "It is inadvisable to burn coke without prior consultation with the makers who can provide feed mechanism of special design con-

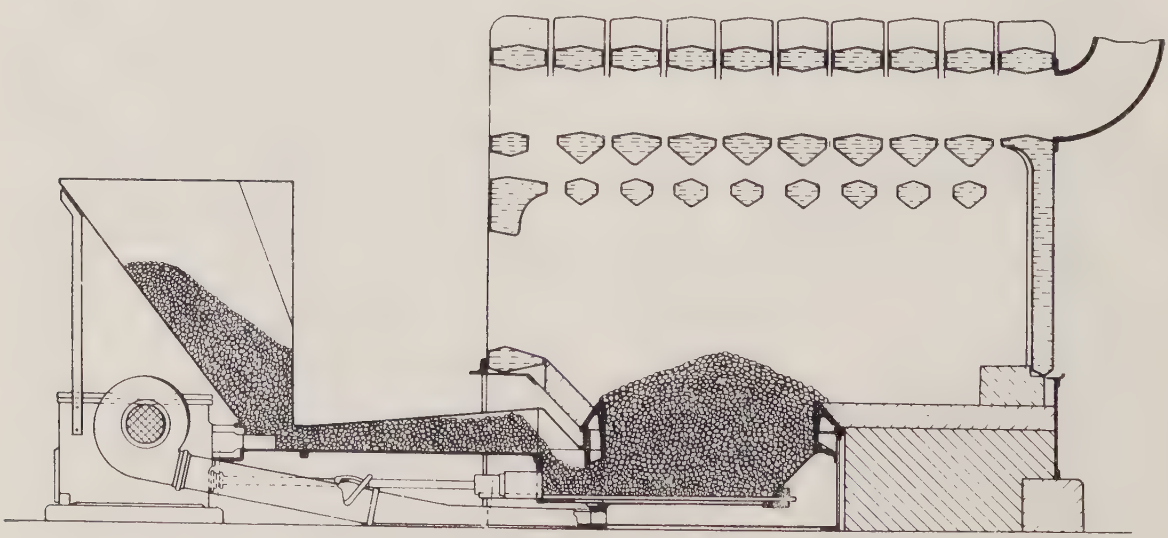

Fig. 7 (a). The Rimer Underfeed Stoker

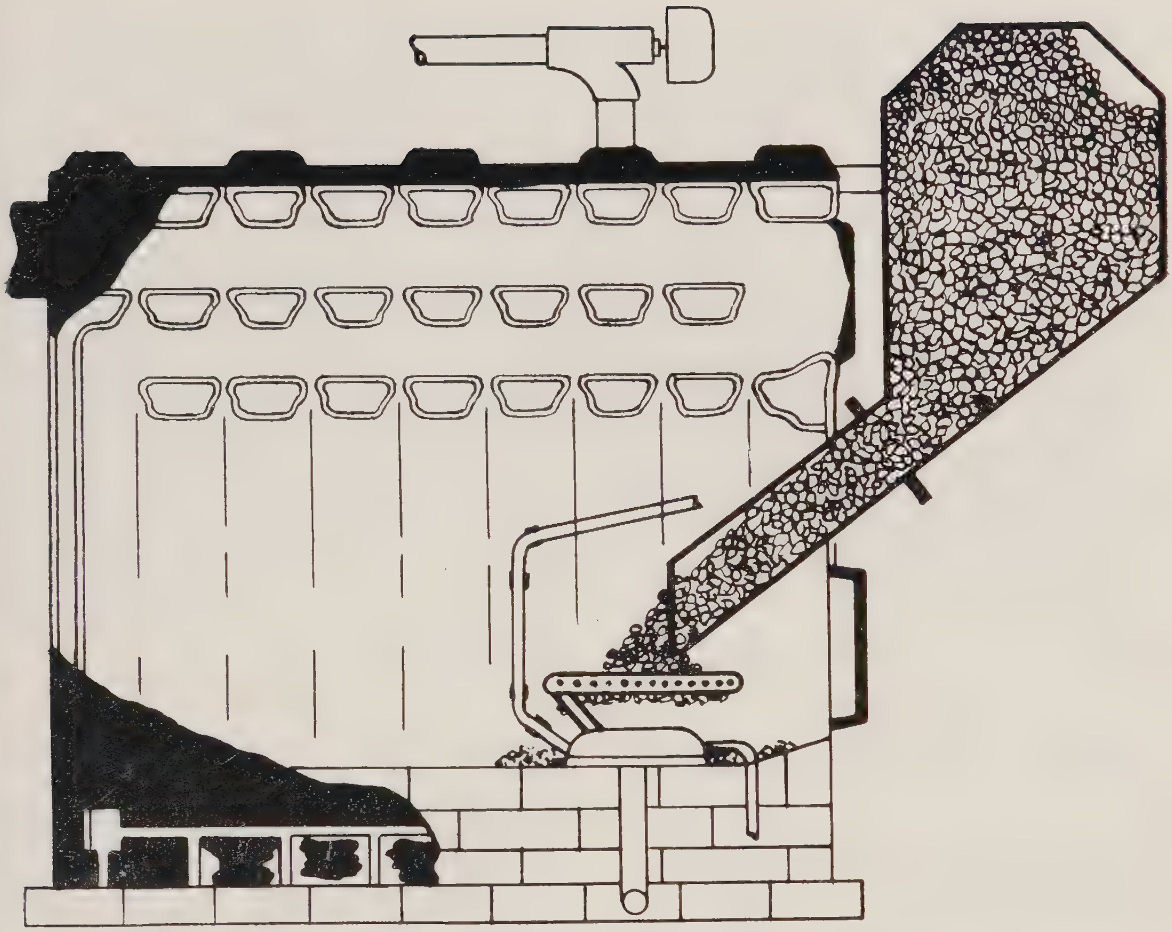

Fig. 7 (b). The Earleymil Automatic Stoker

structed of abrasion resisting metal."

Fig. 7 (*a*) illustrates the ram type of underfeed stoker. With all stokers the best results are obtained when the controls are set so that the fan is running as continuously as possible, not less than two-thirds of the heating period, so that the combustion is maintained at a fairly constant rate.

Fig. 7 (*b*) illustrates a type of automatic stoker which burns Anthracite grains, $\frac{3}{8}$ in. to $\frac{5}{8}$ in. coke or coke breeze. Anthracite grains is the preferred fuel. This stoker feeds the fuel on to a water cooled cone and burner ring to which air is supplied from a fan and motor. Complete thermostatic control is provided and it will be clear from the illustration that the stoker can readily be fitted to existing central heating boilers.

Fig. 7 (*c*) and (*d*) illustrate stokers particularly suited to coke burning; the former burns a small size of Dry Steam coal, coke boiler nuts or a coarse breeze whilst the latter operates best on the larger sizes of coke within the range of $2\frac{1}{2}$ to 1 inch. There are a number of installations of the stoker illustrated in Fig. 7 (*c*) operating on Dry Steam coal and on Anthracite, the size of fuel being duff. This stoker consists of a water cooled combustion chamber into which the fuel feeds by gravity. Combustion air from a fan is delivered through a number of valves (see enlarged sketch), which are preset and ensure very even distribution of air and hence of combustion, through the fuel. Secondary air issues from the fire door which is kept cool by this arrangement. The stoker or pre-burner as it is more generally named delivers hot products of combustion into the boiler: the water jacket is connected to the flow and return pipes of the boiler and this extra heating surface adds considerably to the performance of the installation. Full thermostatic con-

trol is, of course, provided.

The pre-burner illustrated in Fig. 7 (*d*) also has a water cooled combustion chamber with gravity feed from the fuel hopper. A special design feature is that the air for combustion is directed at the fuel surface at high velocity from a tuyere (see the dark slot in the centre where the fuel surface has been cut away). Some of the air penetrates the fuel bed, hence the reason for using a large size of fuel. Complete combustion is ensured by the presence of excess air at this point. The combustion efficiency is very high and it is practicable to, and many burners do, operate with a CO_2 content of the products of combustion as high as 19 per cent. without the presence of CO, thus showing complete combustion. It follows from the small amount of excess air that the temperature of the products of combustion can be very high. This is a definite aid to efficiency and is of particular importance in the furnace heating version of this burner, in which the water jacket of the central heating unit is replaced by a refractory lined combustion space.

The authors have, in this brief review of central heating stokers, dealt with types which can be fitted to existing boilers. Many of these boilers when hand-fired cannot be operated at efficiencies (taken over the heating season) of more than 55 per cent. With the addition of a comprehensive thermostatic control and hand-firing a figure of 60 per cent. might be obtained and a further 5 to 10 per cent. may be added for automatic firing. These efficiencies are recognized as being still too low and more attention is now being paid to the design of boilers having a larger and more effective heating surface, indeed, with some the position has been reached where a low limit thermostat control has to be provided so that the flue gases do not fall below the dew point and cause corrosion of the heating surfaces. Further atten-

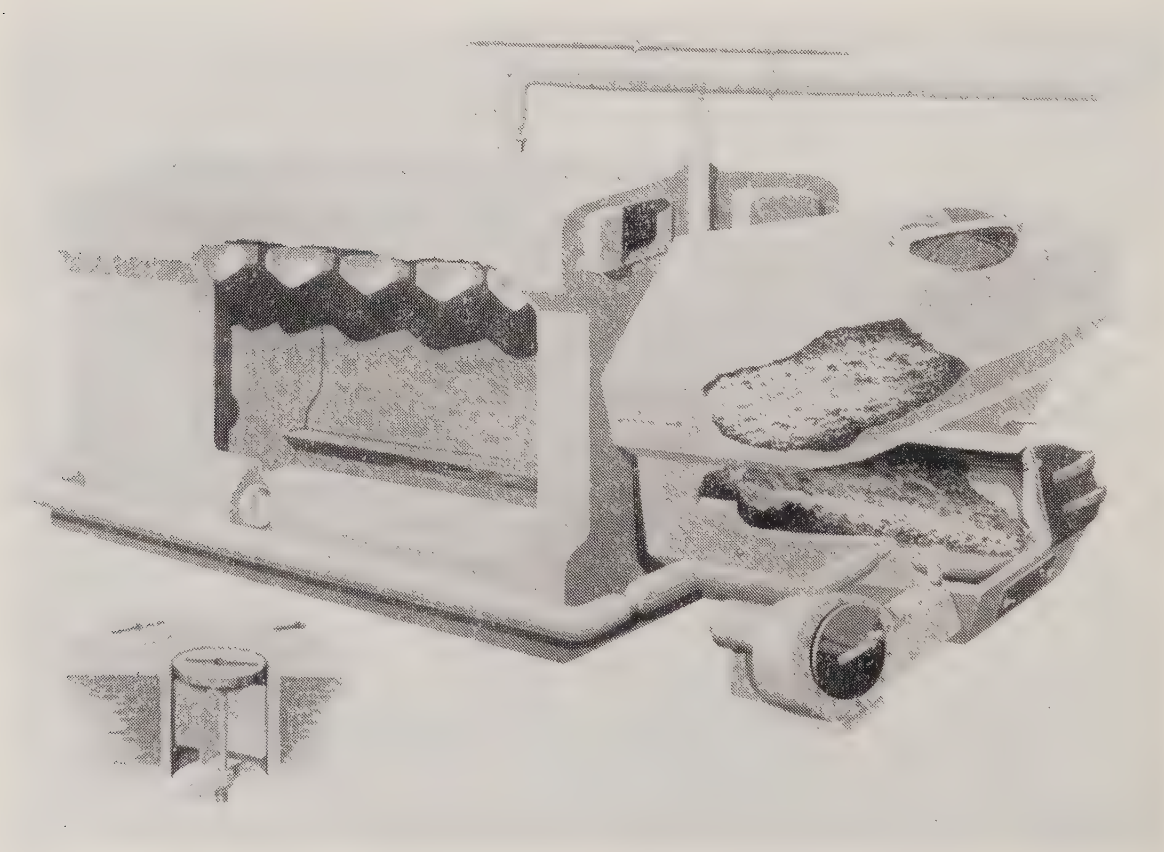

Fig. 7 (c). Suxé Solid Fuel Burner

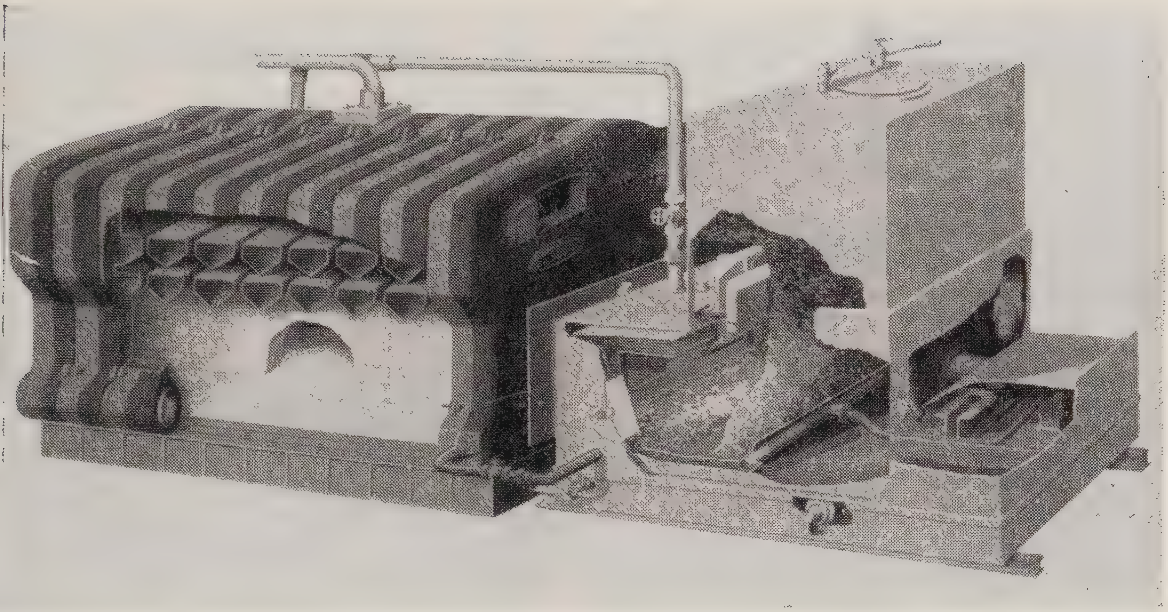

Fig. 7 (d). Bigwood Magnacalor Down-jet Burner

tion is also being paid to the design and provision of automatic clinker-removing devices for central heating and in some cases for domestic boilers. Both of these developments will lead to the increased fuel utilization efficiency that is the aim of all fuel producers and appliance manufacturers.

The authors are conscious that they have not covered all aspects of the utilization of solid smokeless fuels. They hope that the subjects covered will be helpful and instructive, particularly to those concerned with the launching of smokeless zones and would add that the services of the Solid Smokeless Fuels Federation are available to all.

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(2) AVAILABILITY & DISTRIBUTION

by

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1. In this paper the question of the availability and distribution of solid smokeless fuels is considered in relation to the recommendations, firstly of the Domestic Fuel Policy Report of the Fuel and Power Advisory Council of the Ministry of Fuel and Power, March, 1946, C.M.D. 6762 (hereinafter referred to as the Simon Report) that, in order to abolish atmospheric pollution from domestic sources and to reduce the labour and dirt in domestic houses, bituminous coal in all single room domestic appliances should be replaced by solid smokeless fuels or by gas or by electricity; and secondly, the statement in the Report of the Committee on National Policy for the Use of Fuel and Power Resources of the Ministry of Fuel and Power, September, 1952, CMD. 8647 (hereinafter referred to as the Ridley Report) that " although we agree with the Simon Report that a higher efficiency may be achieved with coke in suitably designed fires and that the greater use of smokeless fuel such as coke, anthracite, dry steam coal and carbonized briquettes is highly desirable, there seems no likelihood of a great expansion in the supply of these fuels in the next few years."

2. The annual consumption of house coal in post war years has been of the order of 35 million tons as compared with about 50 million tons before the war. The distribution throughout the country is given in Table 1, which shows region by region the consumption for 1950 of both miners' coal and the house coal supplied to domestic consumers.

Domestic disposals of house coal as tabulated in the Ministry Statistical tables relate to disposals to premises not separately programmed for their supplies. In addition to private residences these premises include shops, offices, hotels, cinemas, institutions and the like and the smaller industrial consumers. It is estimated that under today's conditions up to 4 million tons of house coal are being supplied annually to usages outside the genuine domestic market.

TABLE 1

Consumption of House Coal and Miners' Coal by Ministry of Fuel and Power Regions, 1950

M.F.P. Region	*House Coal: Tons*	*Miners' Coal: Tons*
Scotland	3,712,000	427,000
Northern	1,719,000	1,455,000
North Eastern	2,975,000	1,092,000
North Midland	2,329,000	774,000
North Western	5,161,000	50,000
Midland	2,981,000	368,000
Eastern	1,710,000	—
London	3,880,000	—
South Eastern	1,241,000	30,000
Southern	1,287,000	—
South Western	1,528,000	46,000
Wales	1,667,000	781,000
TOTAL	30,190,000	5,023,000

The target then as visualized by the Simon and Ridley Committees was the production of something of the order of—bearing in mind the increased heat output obtained from solid smokeless fuels in modern appliances—about two-thirds of 35 million tons, say 25 million tons of solid smokeless fuels for the domestic market. Indeed, rather less than this tonnage would be required because both gas and electricity will undoubtedly replace some of the existing

solid fuel space and water heating load especially in the summer.

3. Since the war this country, in company with other European countries, has laboured under a severe shortage of fuels. The distribution of all solid fuels has been under Government direction and domestic supplies in particular have been and continue to be controlled. Under these conditions any large scale redistribution of solid smokeless fuels by the supplying industries so as to increase supplies to the domestic market considered in its narrow sense has been virtually impossible. Nevertheless, despite the difficulties some improvement has been made. Table 2 indicates the solid smokeless fuels now being supplied to the household trade:

TABLE 2

Solid Smokeless Fuels now being supplied to domestic market

	Million tons
Gas Coke	2.50
Hard Coke	.37
Low Temperature Coke: "Coalite" and "Rexco"	.42
Graded Anthracite and Dry Steam Coal	1.63
Smokeless Ovoids ("Phurnacite")	.30
	5.22

The need for more positive action is fully recognized by the solid smokeless fuel industries. Both the National Coal Board and the Gas Council have made public their intention of making available to the domestic market increasing quantities of solid smokeless fuels whilst the development programmes of the Iron and Steel industry and the independent coking plant owners will also provide larger quantities of hard coke for domestic purposes. In their proposals to the Ridley Committee* they called in the national interest for substantial expansion in the carbonization of raw coal and the production of coke. Although their arguments were not in the main accepted and the Ridley Committee decided that the best line to follow in the domestic sphere was the encouragement of a "Utility" fire capable of burning bituminous coal relatively smokelessly at a minimum room efficiency of 40 per cent. it should not be overlooked that the Report fully recognized that:

> "The domestic use of coal is one of the main sources of smoke pollution. It is not only a cost in that it damages health, reduces amenity and causes expenditure on laundry work and building renovation that would otherwise be unnecessary; it is also a sign of inefficiency in the use of coal. By increasing the efficiency of domestic appliances and by extending the use of coke, a great contribution could be made in the domestic sphere towards smoke abatement and towards the establishment of smokeless zones recommended in the Simon Report."

5. A practical approach to the real smoke abatement problem in this country is long overdue.

It is generally accepted that the problem is not capable of solution along the lines of burning bituminous coal on open fires, no matter how they may be designed. Appliances may be evolved to burn coal with little smoke when the fire is freely burning but both at lighting and at replenishment the fire will certainly produce smoke and with overnight burning fires smoke is inevitable during the banking period. Those who so frequently advocate smoke reduction and not smoke abolition should reflect as to the practicability of control and policing in an area in which only a given amount of smoke is permissible for each appliance. Completely smokeless combustion at all times will only be produced in any domestic solid fuel appliance by using solid smokeless fuels.

The replacement by smokeless fuels

* See Appendix XI Cmd. 8647.

of bituminous coal in domestic usages is only capable of attainment step by step as additional tonnages of solid smokeless fuels are made available to the domestic market and as users find themselves able more and more to change over to gas and electricity to meet some part of their needs particularly for summer space and water heating. Both the Simon and the Ridley Reports recommend that intermittent space and water heating for short periods should be taken by gas and electricity.

A realistic approach to the problem is essential if the ultimate goal is to be reached. The need for the abolition of smoke no matter how desirable it may be over the whole country is an immediate and pressing problem for our towns and cities and for the large industrial areas where today it is a menace to both life and property. As a first step attention should be concentrated on the areas of heavy pollution—the Greater London Area, the Black Country, South Lancashire, West Riding of Yorkshire and on the Clyde, Tyne and Tees.

Supposing that all the domestic coal burnt in these areas had to be replaced ton for ton by solid smokeless fuels the quantity required would be of the order of 13 million tons, a figure within the competence of the smokeless fuel industries say on a ten years plan. In practice, of course, because of the greater output of useful heat from solid smokeless fuels in modern appliances, very much less than this quantity would be required even if no part of the existing coal usage was replaced by gas and electricity. To take this big step forward and to eliminate domestic smoke in the areas of heaviest smoke pollution, something less than an additional ten million tons of solid smokeless fuels would be necessary.

The approximate annual production of solid smokeless fuels in Great Britain for all purposes is more than 37 million tons, made up as following:-

	Million tons
Anthracite	4.35*
Dry Steam Coal	4.30†
Smokeless Ovoids ("Phurnacite")	.30
Gas Coke (excluding coke used at gas works for gas manufacture)	11.02
Hard Coke	17.00
Low Temperature Coke "Coalite" and "Rexco"	.45

Much of this solid smokeless fuel is specially produced for essential industrial purposes for which it is irreplaceable. For example, three quarters of the hard coke is required for blast furnaces and foundries, and indeed, the steel produced in this country is entirely dependent on it. Some of the solid smokeless fuel, without special preparation and treatment for which expensive capital equipment would be required, is quite unsuitable for the domestic market and some under present conditions is earmarked under Government direction for essential export.

Nevertheless, there is no doubt that under easier supply conditions and with official support much could be done to change the present pattern of supply and to increase the tonnage made available to the domestic market. Given freedom from restrictions and the right sort of support from both Government and Local Authorities it should be possible to make available ten million tons in this market by 1957 and by 1962 to increase this tonnage to 15 million tons. The approximate breakdown of these prospective tonnages between the various solid smokeless fuels would be as shown in Table 4.

* *M.F.P. Statistical Digest* 1951—Wales deep mined 2.971, Wales open cast .616 and Scotland .76 million tons.

† *N.C.B. Plan for Coal*, p.32—Dry Steam Coals 2 per cent. of total output.

TABLE 4

	1957 *Tons*	1962 *Tons*
Gas Coke	5,000,000	7,000,000
Hard Coke	2,050,000	2,650,000
Low Temperature Coke ("Coalite" and "Rexco")	500,000	2,000,000
Anthracite and Dry Steam Coal ..	2,000,000	2,750,000
Smokeless Ovoids ("Phurnacite") ..	450,000	600,000
TOTALS ..	10,000,000	15,000,000

These tonnages would be made up partly from planned increases in production and partly from withdrawals from other markets in which solid smokeless fuels would have to be replaced by bituminous coal. In considering the tonnages of coal required for such switches it should be borne in mind that each additional ton of solid smokeless fuel supplied for use on modern appliances in the domestic market would, unless the heat requirements of the consumers concerned increase, release $1\frac{1}{2}$ tons of bituminous coal for use in other markets.

8. The task is not only one of persuading domestic consumers of the very real advantages to them and to the nation of changing over from coal to solid smokeless fuels but also the difficulty of inducing large scale industrial and commercial users to turn from solid smokeless fuel to bituminous coal or to some other fuel. Certainly bituminous coal could be used smokelessly in such usages but changes in firing methods and in many instances alternative and expensive firing equipment will be required. There is no doubt that the switches will embarrass many users and will in many instances be resisted. Patently they could not be made overnight. Indeed a lead of some kind from the Government would be desirable if not essential to bring about the changeover in fuels within a reasonable time.

9. The domestic solid fuel market is speculative and has its special difficulties. It is mainly a winter load. Although nationally approximately two-thirds of the gross annual sales take place in the winter six months the proportion in some parts of the country, particularly in the south, is much higher. Over the last three years during which house coals have been in short supply the weekly tonnage distributed by merchants has ranged from 750,000 tons in the winter to just over 400,000 tons in midsummer. These are national figures and the figures for individual distributors show a much wider fluctuation. The weekly deliveries of one of the largest London merchants were in the proportion of 10 to 1. The national weekly distribution of domestic gas coke between the peak winter period and midsummer is in the proportion of 4 to 1.

Experience has shown that very few domestic consumers will stock up in summer against their winter needs even when they gain a substantial price advantage. Many of them have entirely inadequate storage facilities to do so. The solid fuel producing and distributing industries must maintain the machinery and personnel to supply the public with the fuel they need as and when they want it. This is the basic problem of the domestic solid fuel trade. Order offices, depots, lorries and staff have to be maintained throughout the slack period in order to meet the period of peak winter demand.

An important and essential feature of domestic business is the building up of substantial stocks during the summer against the winter's needs which cannot be met from the winter production. House coal stocks in merchants' yards at the beginning of winter range from 2 to $2\frac{1}{2}$ million tons. The gas industry which normally produces two-thirds of its coke in the winter even with its present small share of the domestic market, carries between $1\frac{1}{4}$ and $1\frac{1}{2}$ million tons of coke at the end of summer to meet the requirements of its space and water heating market. Such stocks are of course widely distributed over the country. Although the stocks cost money to put down and to pick up

which is ultimately paid for in the price paid by the consumer, they are essential to meet the peak winter demand which could not be dealt with by the present long distance transport system particularly during abnormally hard weather.

From year to year or from winter to winter there are material fluctuations in domestic demand depending upon the severity of the weather. A green winter often leaves a good part of these stocks in the hands of the suppliers to be carried forward for the next heating season.

Enough has been said to give a general indication of the special difficulties which obtain in the domestic market. In spite of these the solid smokeless fuel industries regard the market as one in which, in the national interest, they have special responsibilities. It is their intention to make available in this market a steadily increasing tonnage of solid smokeless fuels as conditions permit. As a pre-requisite to expansion in the market it is regarded as essential that three conditions should obtain.

Firstly, that solid fuel supplies should be such as to give all users desiring to use solid smokeless fuels assurance that supplies will not be withdrawn under direction to help eke out inadequate supplies of other fuels.

Secondly, that the new solid smokeless fuel appliances should be freely available to all users at reasonable prices.

Thirdly, that merchants and other distributors of solid fuel will in conjunction with the producers, provide consumers with an efficient Advisory Service; that they will familiarize themselves both with the various types of solid smokeless fuels and the wide range of appliances on which they can be efficiently and economically used; and that in order to convert consumers to the use of solid smokeless fuels they will, in co-operation with the fuel producers, set about giving help and advice to users on:

(*a*) the correct installation and maintenance of the appliance.

(*b*) the choice of the right solid smokeless fuel to suit the appliance, and

(*c*) the proper operation of the appliance with the particular solid smokeless fuel recommended.

10. All domestic solid smokeless fuels are carefully prepared and sized according to the type of appliance in which they are to be burned. Anthracites and dry steam coals are natural smokeless fuels which together with smokeless ovoids (" Phurnacite ") are mainly supplied for use with closed appliances—heating stoves, boilers and cookers. For the domestic market, anthracites and dry steam coals are furnished as closely graded nuts ranging in size from 2 to 3 inches down to peas $\frac{3}{8}$ to $\frac{5}{8}$ inch and grains $\frac{3}{16}$ to $\frac{3}{8}$ inch. They are compact, dense, slow burning fuels having a bulk density from 45 to 50 lb. per cubic foot. Cokes, gas, hard and low temperature (" Coalite "), are manufactured fuels produced by the carbonization of coal in gas works, coke ovens, and low temperature plants. Their density and hardness vary considerably depending upon the carbonization method, ranging from 20 lb. per cubic foot for continuous vertical retort gas coke to 31 lb. per cubic foot for hard coke and intermittent and horizontal retort gas coke. Domestic cokes are carefully sized and depending upon their size they are suitable with very few exceptions for use in all modern domestic appliances. Full information on the preparation and methods of utilization of solid smokeless fuels is given in the complementary paper presented to this Conference by Messrs. Eaton, Hall and Jacob.

With the exception of gas coke the production of solid smokeless fuels is in the main located in or near the coalfields as shown in Table 5:

TABLE 5

Production of Solid Smokeless Fuels by Regions

M.F.P. Region	Gas Coke excluding coke used at Gas Works for gas making Tons	Hard Coke Tons	Anthracite and D. Steam Coal Tons	Smokeless Ovoids ("Phurnacite") Tons	Low Temp. Coke ("Coalite" "Rexco") Tons	TOTAL Tons
Scotland ..	893,000	929,000	760,000			2,582,000
Northern ..	302,000	5,240,000				5,542,000
N. Eastern ..	571,000	3,508,000			160,000	4,239,000
N. Midland ..	612,000	3,308,000			290,000	4,210,000
N. Western ..	1,744,000	874,000				2,618,000
Midlands ..	1,176,000	533,000				1,709,000
Eastern ..	660,000	—				660 000
London ..	2,085,000*	205,000				2,290,000
S. Eastern ..	1,631,000*	—				1,631,000
Southern ..	519,000	—				519,000
S. Western ..	610,000	—				610,000
Wales ..	213,000	2,494,000	7,890,000	300,000		10,897,000
TOTAL ..	11,016,000	17,091,000	8,650,000	300,000	450,000	37,507,000

* Including approx. 953,000 tons hard coke produced by North Thames and South Eastern Gas Boards.

The approximate quantities of solid smokeless fuels at present supplied to the domestic market in the various parts of the country are as shown in Table 6. Some of the figures shown are estimates and the table should only be taken as giving a general guide as to the present position. For convenience of comparison the figures for house coal and miners' coal have been included:

the price of bituminous house coal is relatively high and that over 20 per cent. are in London.

In the case of Welsh anthracite, dry steam coal and Phurnacite, the figures show an even greater disparity in usage, nearly 90 per cent. being sold in the south and nearly one-third in London. On the other hand the sale of Scottish anthracite is mainly confined to Scotland.

TABLE 6

Approximate Present Regional Distribution of Solid Smokeless Fuels to Domestic Market*

M.F.P. Region	Gas Coke Tons	Hard Coke Tons	Anthracite & D. Steam Coal Tons	Smokeless Ovoids "Phurnacite" Tons	Low Temp. Coke "Coalite" "Rexco" Tons	TOTAL S.S.F. Tons	COAL** House Coal Tons	COAL** Miners' Coal Tons
Scotland ..	125,000	5,000	250,000	11,000	13,500	404,500	3,712,000	427,000
Northern	60,000	70,000	—	2,500	3,000	135,500	1,719,000	1,455,000
N.E. ..	125,000	70,000	14,000	9,000	57,500	275,500	2,975,000	1,092,000
N. Mid. ..	140,000	60,000	30,000	11,000	32,500	273,500	2,329,000	774,000
N.W. ..	375,000	16,000	45,000	17,000	111,500	564,500	5,161,000	50,000
Midland ..	275,000	17,000	59,000	19,000	12,000	382,000	2,981,000	368,000
Eastern ..	175,000	57,000	100,000	30,000	35,500	397,500	1,710,000	—
London ..	525,000	20,000	448,000	58,000	73,000	1,124,000	3,880,000	—
S.E. ..	385,000	5,000	197,000	35,000	46,500	668,500	1,241,000	30,000
Southern ..	130,000	12,000	191,000	35,500	16,500	385,000	1,287,000	—
S.W. ..	155,000	23,000	203,000	48,000	14,500	443,500	1,528,000	46,000
Wales ..	30,000	15,000	95,000	20,500	4,000	164,500	1,667,000	781,000
TOTAL ..	2,500,000	370,000	1,632,000	296,500	420,000	5,218,500	30,190,000	5,023,000

* Excluding Northern Ireland and Channel Isles.
** Figures for 1950: *M.F.P. Statistical Digest.*

From this table it can be seen that just over 60 per cent. of the sales of solid smokeless fuels are in the southern half of the country where

Having regard to the special usages of anthracite and dry steam coal and the limited increased availability of a further million tons which in present

circumstances is as high as may be anticipated in the next decade, it is suggested that it is highly desirable that these fuels in the foreseeable future should be reserved for the many makes of closed appliances which can be operated with efficiencies of the order of 60 per cent. From this it is inevitable that the main replacement solid smokeless fuels for substitution for bituminous coal in open fires will for some time to come have to be gas, hard and low temperature cokes which are more generally available up and down the country and of which very substantial tonnages may be expected in the near future.

12. In concluding this short paper it must be said that the abolition of smoke from domestic chimneys is essential not only from the standpoint of smoke abatement but also to prevent waste of fuel. Smoke is waste. The problem of eliminating domestic smoke is essentially the replacement of bituminous coal by solid smokeless fuel supplemented by gas and electricity for summer water and space heating.

The present annual consumption of house coal of about 30 million tons as shown in the statistics of the Ministry of Fuel and Power includes not less than 4 million tons of coal used in non-domestic establishments. The present consumption of house coal in single room domestic appliances is of the order of 26 million tons. At least a further 4 million tons is capable of economic replacement by gas or electricity for summer water and space heating. Having regard to the much greater utilization efficiency or, stated another way, the much higher useful heat output per ton, of solid smokeless fuels in modern appliances, not more than an additional 15 million tons of solid smokeless fuel would be required to replace the remaining 22 million tons of bituminous coal in single room domestic appliances.

Just over 5 million tons of solid smokeless fuels are already being supplied to domestic consumers. Prospective increases in production couple with Government sponsored re-dis- tribution of existing supplies to non- essential markets could bring thi tonnage to 10 million tons by 195 and to 15 million tons by 1962. Thi would still be short by 5 million ton of the quantity required to replace al bituminous coal now being consume in the domestic market.

The abolition of smoke is a vita and urgent problem mainly insofa as the areas of heavy smoke pollutio are concerned. In these areas abou 13 million tons of bituminous coa are now being consumed in domesti open appliances. Pre-supposing tha 2 million tons of this can be economi cally replaced by gas or electricity fo summer water and space heating, a additional 7 or 8 million tons of soli smokeless fuel would be needed to re place the remaining 11 million tons o bituminous coal.

The Ridley Committee in thei report last year stated:*

> " (2) One heavy social cost to th community is the smoke pollutio usually produced when raw coal i burnt inefficiently. It is impossibl to measure all this cost in money Estimates have been cited from tim to time for parts of it (for instanc in the Egerton Report (Appendi A 4-5)). In real terms it i certainly enormous, as every-da observation in our large towns an cities shows—most clearly to thos who know conditions abroad, wher less coal is burnt raw in inefficien conditions. Among the social cost are the loss of sunlight and th harm to the health of the citizens the reduction in the amenities o town life, the damage to building and textile fabrics, the extra cost of painting, washing and laundry and the loss of food productio which results from the smok deposit in the countryside aroun the towns. These are only some o

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* Appendix IV. Cmd. 8647.

the main losses which the community endures through smoke.

"(3) But apart from the losses which the community suffers from smoke pollution, there is the inefficiency of which smoke is the visible symptom.

"(4) The main sources of smoke pollution in the United Kingdom are:

(i) The millions of households which use raw coal burnt in old-fashioned open grates as the main source of heat comfort. There are perhaps 12 million such open fires in regular use—and producing a million tons of smoke. Thus the townsman pays heavily for smoke, both directly as a coal consumer, and indirectly as a citizen living in dirty air.

(ii) Smaller industrial boilers and furnaces burning raw coal.

(iii) Steam railway locomotives."

The committee expressed the view hat the more general adoption of noke abatement bye-laws by local authorities and the establishment of more smokeless zones depended on having enough smokeless fuels and suitable appliances and went on to say that as they became available there was a good case for more widespread declaration of smokeless zones in the causes both of reducing the social costs of smoke pollution and of improving fuel efficiency.

Nearly two million modern appliances designed for burning solid smokeless fuels are now made every year. We have shown how the solid smokeless fuels can be made available if there is a real appreciation by Government and by Local Authorities of the urgency of the matter. The appalling London fog of last winter in which 4,000 people lost their lives was sufficiently serious to focus attention on this matter. Surely the Government Committee now sitting will be bold enough to make recommendations which can be quickly implemented and give heart to organizations such as yours who have fought for years to abolish the smoke evil.

Introductory Summaries

Sir Patrick Dollan, Sessional Chairnan, in introducing the authors of the apers, said that a thick fog in the Clyde Valley would cost the inhabitnts and industry a loss of £2,000,000 er day. This represented the damage aused to household furnishings and quipment, clothing, the suspension of industry and transport, the wholeale dislocation of trade and commerce nd the health of 2,000,000 people.

The average housewife estimated the og damage caused to her home at £1 per day. There were almost 00,000 houses in the Clyde Valley rea, all of which suffered personal nd property injury because of fog. Substantial evidence of this occurred n the city and district on the previous lay. Most of the loss, which in an average period probably amounted to £10,000,000 per annum, could have been avoided by the adoption of modern appliances for the prevention of domestic and industrial smoke.

All those who stayed at home during the Glasgow Fair holidays, said Sir Patrick, knew that during that season Glasgow was one of the healthiest and most pleasant cities in Northern Europe. It was only in those two weeks that the city could be described as "smoke free."

But although conditions were still bad, they were better than in 1891 when Mr. John Nicol, the City Chamberlain, directed attention to the fact that abnormal infantile and adult mortality in Glasgow was caused by excessive smoke. The all-age

death rate was then 21 per 1,000 persons and the infant mortality 148 per 1,000 births. Because of the reduction of smoke and other social reforms, the overall mortality rate had been reduced to 13 per 1,000 and infantile mortality to 41 per 1,000 births. This reduction represented a saving of more than 12,000 adult and infant lives every year—in terms of life insurance a monetary value of £48,000,000 per annum.

He said that Glasgow could be made as healthy as any other city in the world. This was proved by the statistics of the Health Department. Infant and adult mortality was still wasteful in the smoky and congested areas in which the mortality rate for infants ranged from 40 to 78 per 1,000. The average for the city was 41 and in the smokeless zones or wards of the city it was as low at 30, and in one ward 13, which must be one of the lowest mortality rates for infants in the world.

Excessive smoke was a crime against the community and persistent offenders should be prosecuted and punished.

He said that Glasgow should also be prepared to spend money on smokeless zones, which were cheaper to provide than premature funerals for adults and children.

Dr. F. J. Eaton (Solid Smokeless Fuels Federation) in introducing the first paper said all would agree wholeheartedly with the remarks of the Chairman and would wish him and Glasgow success in achieving a smokeless Glasgow in the near future.

The paper which he had the honour to present, was divided into the two parts of, first—Production, and second —Utilization, and the emphasis was on the need, of solid smokeless zones particularly, for the types of appliances on which solid smokeless fuels could be burned with advantages in economy, efficiency and convenience.

All solid smokeless fuels were carefully prepared for the market, and were sized between certain limits to produce a size grade suitable for each market. These size grades were given in Table 1. Table 2 gave the recommended sizes of solid smokeless fuels for domestic appliances, whilst Table 3 gave similar data for typical large central heating, horticultural and small steam boiler installations. All the natural fuels—the Anthracites and Welsh Dry Steam Coals—were cleaned of " dirt " in washeries, whilst the low temperature cokes " Coalite " and " Rexco " and the carbonized ovoid fuel " Phurnacite," were prepared from specially selected coals.

The information on the production and preparation of solid smokeless fuels had been given to emphasize the wide variety of these fuels, each of which had clearly defined and characteristic properties. All of them had this important common property—they burned smokelessly. One of the problems of fuel utilization was to design appliances suitable for as many alternative fuels as practicable, the ultimate aim being the all-fuel appliance. It was within the memory of all present that in the past appliances were designed for specific fuels and the names " anthracite stove " and " coke boiler " were evidence of this policy. The position was changing, however. It was a requirement of the Ministry of Fuel and Power domestic approval scheme that all appliances should pass the performance tests on solid smokeless fuels and bituminous coal. In the Ministry requirements, it was significant that the pass standards were higher for solid smokeless fuels than for bituminous coal.

Referring to Part 2 of the paper, it was suggested that the Members of the Society directly interested in launching smokeless zone schemes, were in a favourable position to obtain fuel consumption data on both domestic and industrial equipment. Such data were urgently required as having a direct bearing on National Fuel Policy. In areas where a smokeless zone was projected, a census was generally taken of all appliances in the zone. Inefficient, smoke-producing appliances had to be improved or

placed, certainly all old-fashioned omestic appliances had to be re- ewed, and this provided the oppor- nity of introducing modern equip- ent, correctly installed, which should ve fuel. The information required as, how much fuel would be saved in actice by introducing the more ficient equipment. So far all figures r savings in fuel had been estimates ased on laboratory or on trial sts carried out under ideal conditions id such figures could be misleading.

Figures 4 and 5 gave examples of ch type of domestic appliance, and each type there was a very wide oice. Prospective purchasers would well to consult one of the lists of pproved Appliances available from e Solid Smokeless Fuels Federation from the Coal Utilization Council, there was the Handbook of pproved Coke Burning Appliances sued by the Gas Council which also ontained information on the selection the most suitable types of appliances r the duty required. Initial cost of e appliances was always a most nportant consideration and doubtless any present were concerned as to ow this cost could be met. The most ficient appliances were invariably e most expensive and designs were eing developed which saved on stallation costs. Such appliances ould be the tenant's property in place a landlord's fixture and in this ay the tenant would have within his wn control the choice between itial cost and the subsequent running ost of fuel.

Special attention was directed to the amples of actual costs, incurred by arious Local Authorities and property wners, for the supply and fixing of arious domestic appliances. The ost of this work had, in common with l building work, been high in recent ears, but with more experience in e difficulties involved, it was likely at costs might fall. The Authors ere particularly interested in this ubject and would welcome all avail- ole similar figures of costs.

For the heating of medium-sized offices, shops and banks, central heating by radiators or warm air was recommended. Attention was drawn to the extent of fuel wastage which could result from overheating and excessive ventilation. Overheating could be avoided by the use of thermostatic control, whilst excessive ventilation should be avoided by the weather stripping of windows and doors.

When this paper was being prepared, there was some doubt as to whether to include the use of solid smokeless fuels on the larger central heating boilers and for steam raising. After consultation with my colleagues on the Executive Council of the Society, Messrs. Law and Redstone, it was felt that although in this field bituminous coal could be burned smokelessly, there were still a considerable number of installations where it would be preferable to burn smokeless fuels. An example would be hand-fired central heating boilers of up to about 750,000 B.Th.U. output. Above this size it would be economic to instal automatic stokers. It was pointed out that the improved efficiency of automatic stokers was, in large part, attributable to the provision of thermostatic control of combustion, which was an essential part of the equipment. The performance of hand-fired boiler installations could be considerably improved by the installation of thermostatic controls. The underfeed stoker, commonly installed for burning bituminous coal, was not normally suited to cokes, or anthracite, although perfectly satisfactory on Welsh Dry Steam Coals. The Stokers illustrated in Figs. 7 (a) and (b), were normally operated on the smaller sizes of the natural solid smokeless fuels. The pre-burner illustrated in Fig. 7 (c) was suitable for the smaller sizes of coke, anthracite and dry steam coals (see Table 3 (b)), whilst the pre-burner illustrated in Fig. 7 (d) was particularly suited to gas and hard coke of 2″ to 1″ square mesh size.

J. O. Cooke (Solid Smokeless Fuels Federation) introducing the

second paper said that it was hardly necessary to say that smoke was dangerous to the health of the people and was costly to the community. The subject had been adequately dealt with elsewhere at the conference. He believed it was true that today the public at large were much more alive to it and that a position had arisen in which there was a much better chance of positive steps being taken to put an end to the smoke evil.

Smoke arose almost entirely from the inefficient and wasteful combustion of bituminous coal. Smoke elimination in the industrial usages of coal was largely a matter of installing proper equipment for efficient combustion. Smoke was a certain indicator of fuel wastage.

The domestic chimney was the hard core of the smoke abatement problem. Bituminous coal could not be burnt without smoke in domestic appliances. Smoke elimination from the domestic chimney was entirely dependent upon barring coal from the domestic market.

Their contribution to the conference showed how sufficient solid smokeless fuels could be made available to the domestic market in order to replace the bituminous coal now being used in the household trade and how smoke from domestic chimneys might be abolished by the use of solid smokeless fuels supplemented by gas and electricity for summer water heating and intermittent space heating.

There could be no doubt as to the desirability of the change. The large tonnages of coal at the present time being used inefficiently in domestic open appliances were responsible for a great part of the pollution of the air we breathe. In domestic appliances coal could not be burned without considerable smoke production. In large boilers with automatic stokers and special firing equipment coal could, of course, be burnt with little or no smoke.

The simple issue was largely the substitution of solid smokeless fuels for coal in the domestic open appliances and the substitution, where possible, in large scale usages of coal for solid smokeless fuels where coal could be burnt comparatively smokelessly.

It was easy to criticize the piecemeal approach to smoke in this country, but the going had been hard. The opposition was strong and the difficulties many. Progress had been slow and gradual. It had taken a calamity to force the matter to the attention of the public and to bring to pass an authoritative investigation of the nature, causes and effects of air pollution.

Against no little resistance smokeless zone schemes had been started in a few comparatively small unrelated areas. They were certainly not unimportant and we would not minimize their value. They showed the way. We would urge, however, a realistic approach to the problem from the national standpoint.

The present consumption of house coal in domestic appliances was about 26 million tons a year. Of this at least 4 million tons, probably nearer 6 million tons, was capable of economic replacement by gas or electricity for summer water heating and intermittent space heating. Bearing in mind the much higher useful heat output per ton of solid smokeless fuels in modern appliances when compared with coal, not more than an additional 15 million tons of solid smokeless fuels would be required to replace the remaining 22 million tons of bituminous coal.

Indeed, to say that one ton of solid smokeless fuel would provide the same heat service from modern appliances as would $1\frac{1}{2}$ tons of house-coal was a conservative statement.

Consideration of the Ridley Report showed that, dependent on type of appliance, the appliance room efficiency for coal was in the range of 25 to 45 per cent., whereas for coke the range was 35 to 55 per cent.

It was, too, interesting to note from their laboratory experience that it was difficult for an appliance, when opera-

ng on coal, to reach the minimum andards, although of course they ere lower than for coke by one third.

No doubt, however, from the users' oint of view, it was cost that was nportant, and on that score Mr. ooke said he could do no better ıan to draw attention to a speech at a oint Meeting of the North Western ivisional Council of the North /estern Section of the Institute of uel in Manchester last year by Dr. C. Weston of the Building Research tation on "House Heating." The eech was reported in SMOKELESS IR No. 84 (Winter, 1952), and escribed recent experimental investi- ıtions in houses at Abbots Langley ıd elsewhere and explained the ethod of carrying out the trials, mote recording, tenant rotation, etc. he effects of tenant habit—window ɔening, water consumption, econo- ic factors and so on were discussed. the address Dr. J. C. Weston ated:

"In one half of the houses for one half of the winter period the occupants used only coke; in the other half only coal. For the second half of the period each group of houses went on to the other fuel. By this means any individual differences in usage were cancelled out. It was found, over the whole period, that the weight of coke consumed was 35 per cent. less than the weight of coal. Further, after the trial, a majority of the householders stated that they preferred coke to coal."

The need for the abolition of smoke no matter how desirable it might be er the whole country—was an mediate and pressing problem only r the large industrial areas where day heavy smoke pollution was a wnright menace to both life and operty.

He said that in those areas about million tons of bituminous coal re now being consumed in domestic pliances. Presupposing that 2 mil- n tons of this could be economically placed by gas and electricity for summer water and space heating, an additional 7 or 8 million tons of solid smokeless fuels would be needed to replace the remaining 11 million tons of bituminous coal.

Rather more than 5 million tons of solid smokeless fuels were today being supplied to domestic consumers. Prospective increases in production coupled with Government sponsored re-distribution of existing supplies to non-essential markets, could bring this tonnage to 10 million tons by 1957 and to 15 million tons by 1962.

There was little doubt, however, that the re-distribution of solid smokeless fuels in the markets to increase the tonnage made available to householders would call for Governmental direction.

The present industrial and commercial usages of solid smokeless fuels in which other fuels could be substituted were satisfactory, profitable and long-standing markets with some advantages to the fuel producers over the domestic market. To change the present pattern of supply, so as to increase substantially the tonnage made available to the domestic market, would call for the strongest effort, not only to demonstrate to domestic consumers the very real advantages of them and to the nation of changing over from coal to solid smokeless fuels, but also to persuade large scale industrial and commercial users to turn from solid smokeless fuels to bituminous coal or some other fuel. Domestic consumers changing to solid smokeless fuels were saving themselves money, but industrial users changing from coke and other solid smokeless fuels to other fuel would, in many cases pay more for their heat service, and, additionally, might have to buy alternative and expensive firing equipment.

Mr. Cooke said that experience had shown us that exhortation got us nowhere. In their opinion, if the changeover in the markets was to be brought about in a reasonable time, a lead from Her Majesty's Government was essential.

F. Taylor (Salford) dealt with the availability of coke since May, 1952, when the Minister rejected Salford's smokeless zone scheme which included 5,000 houses, a few small works and other premises. The gas and low temperature carbonization industries had stated at the inquiry that they would be able to cater for the needs of the proposed zone from contemplated increased production. In the following October, the Minister of Fuel and Power offered to each householder in the country an additional half-ton of solid fuel during the winter period stipulating that it must be taken in the form of coke.

During last summer production figures of the gas industry for the year ended March, 1953 became available and it was then seen that coke production had increased by 2.4 per cent over 1951/2 in the North West, but due to factors connected with trade recession in textiles, there was an increase of 4.1 per cent in the amount available for sale, and in case it might be suggested that the North West coke was needed in the South East, it should be noted that the average increase in coke output throughout the country had been 2.1 per cent for sale. Sales in the North West had fallen by 6.4 per cent compared with a fall of 0.5 per cent in 1951/2, and throughout the country sales were down by 0.7 per cent, In spite of a threefold increase in exports (similar throughout the industry) North West stocks of coke at the end of March stood at 286,000 tons or four and a half times higher than 12 months earlier. National stocks were 793,000 tons, more than double March, 1952. Mr. Taylor asked if it was a matter for surprise that the Gas Board was conducting an intensive coke sales campaign? He had no doubt that the low temperature carbonizing people had increased their output.

The unrestricted establishment of smokeless zones would create only chaos, but he felt sure that a few well chosen schemes would provide a steady home market for a commodity now beginning to flow over the tops of the gas works walls, as it had done three years ago and had then been exported.

Touching on the subject of domestic solid fuel appliances, Mr. Taylor submitted that the cost of replacements was the biggest obstacle to smokeless zones. Who was to pay? Yet the old grates and ranges would burn solid smokeless fuels, even if they did it as inefficiently as when burning bituminous coal; Yorkshire and Lancashire ranges did it only too well. He had found that the new grates were a good investment, but were more economical in the use of fuel when it was smokeless, always provided the appliance was correctly used and that suggested the need for instruction in their use if the utmost fuel economy was to be effected.

Mrs. D. M. Charlton (President, Women's Advisory Council on Solid Fuel) after congratulating the authors on having presented two absorbing papers, added that she was particularly interested to see listed in the first paper on page 53 those organizations the authors considered were assisting in the propagation of the solid fuel story. She was sorry not to see there the name of her own body, The Women's Advisory Council on Solid Fuel, which was devoting the whole of its time to the problem before the meeting. She agreed with much that had been said by other speakers and particularly endorsed the dictum that the housewife's point of view tended to be neglected to the detriment of the nation as a whole.

J. S. Hales (British Coal Utilization Research Association) first pointed out that the word " sunlight " had not so far been mentioned throughout the whole conference. Whatever the medical doubts might be as to whether the December deaths were caused by sulphur, smoke or carbon monoxide, it was obvious that " smog " materially reduced sunlight and that was something which must surely be admitted by all to be harmful.

With regard to the paper by Commander Buist and Mr. Cooke, which gave an estimated figure for the tonnage of smokeless fuels to replace bituminous coal, Mr. Hales thought that figure might be an underestimation if the authors were thinking of using the fuel in built-in open fires of the type now in common use, and illustrated at the top of fig. 5 in Dr. Eaton's paper. Such fires gave room heating efficiencies of only about 20 per cent and even with smokeless fuel they were still only of the order of 25 per cent.

On the other hand, if the authors of the paper had in mind the use of really

icient appliances such as stoves, free-
inding open fires and closed fire boilers,
was possible that the tonnage of smoke-
s fuels suggested would prove to be an
erestimate.

T. N. Dent (South Western Gas Board)
mmenting on the authors' reference to
e task of persuading domestic consumers
the very real advantages of smokeless
el, said that so far as gas coke was
ncerned, to claim a successful domestic
arket, this fuel must be competitive in
ice with coal, operate satisfactorily in
e open grate or closed stove, and give
e housewife at the very least no more
ork in keeping her home clean than when
ing coal. When those requirements were
et coke would soon begin to sell itself,
t the tendency was still for coke to be
ed only when coal was not available,
d under these circumstances progress
wards eliminating that 0.9 million
ns of smoke pollution per annum would
painfully slow.

Mr. Dent suggested that three practical
eps should be taken to increase the
pularity of coke in the domestic field,
z:

The national coal price structure to
ovide for a lower coal price to the gas
d coke producers than to other markets.
hilst the principle of freedon of choice
s maintained, if our coal was to be
nsumed wastefully and at a high cost
maintaining the nation's health and
ildings, then such consumers should be
quired to pay more for this doubtful
privilege."

If coke prices were reduced as an
centive to sales without an initial
duction in the cost of coal carbonized
d the balances made up by an increase
the price of gas, this would defeat its
vn object since gas itself is a primary
nokeless fuel in both the domestic and
dustrial fields.

Availability to the carbonizing in-
stry of adequate supplies of good
king coal of low ash content and free
om shale.

Gas Works in the South West of
gland were still having the bitter
perience of carbonizing a percentage of
als with an ash content of over 20 per
nt; the coke from such coals, with
arly half of it "inert" was literally
burnable and even an occasional
all quantity delivered to the house-
lder was often sufficient to dissuade a
nsumer from ever trying coke again.

As far as shale was concerned, although
the earlier paper had described how stone and dirt was removed at the colliery, it was apparent that this was not yet wholly effective or common practice throughout the country.

3. Whilst there were available some excellent publications advertising the use of coke, Mr. Dent said that he was keenly disappointed at their almost complete absence from the conference bookstall; there was still room for an all-out publicity campaign designed to eradicate the old idea, which was still all too prevalent, that coke was a waste product of coal, or coal from which the heating value had been extracted.

It should be emphasized that coke was not a waste product; it was a smokeless fuel produced by processing coal under scientific control and then carefully sized to suit the individual purposes for which it was to be used.

In our publicity we should not always think of getting the story over to the "man in the street;" their appeal must be directed more vigorously to each "woman in the home" who was more concerned with her household budget and keeping the house warm and clean than with her own contribution from the chimney stack to the impressive tonnage of smoke pollution in the atmosphere.

The task then was not only to persuade the domestic consumer of the advantages of using smokeless fuel but also to market a fuel of consistent good quality and cheaper than coal, which could prove to the householder that it was the best and when this was achieved some of the special difficulties to which the authors referred would begin to recede and the domestic fuel market, as far as coke was concerned, would cease to be a speculative one.

Mr. Dent congratulated the authors on their combined efforts to give a most interesting, informative and useful paper.

G. H. Wilkinson (Corby) said that he was always amused when the production of hard coke was discussed in relation to smokeless fuel. The smokeless production of smokeless fuels might well be a suitable subject for discussion.

Coke ovens had probably the highest nuisance value per ton of coal used of any industrial fuel burning appliances. Without entering into details, the main sources of pollution were, firstly the very structure of the ovens as it affected charging and gas removal, and secondly coke quenching. That the British Coke

Research Association was fully aware of the first was obvious from the report published by them in 1946. However, the recommendations made for reducing the nuisance were punitive, and one of the chief recommendations—the double collecting main—was even now being discredited. The fact was that appreciable reduction of pollution was impossible with the present type of ovens. Was he correct in presuming that the industry was still concerned about the fumes and dust emitted, if not because of the nuisance to the public, at least because of the labour troubles they created?

As regards coke quenching, it was appreciated that the alternative method of dry coke cooling was costly and uneconomic if the resultant waste heat could not be utilized. However, could any information be given as to whether research was being undertaken into the possible reduction of emissions from quenching towers, or modifications of the dry coke cooling process?

Councillor G. B. Jones (Huddersfield) said that one of the difficulties a municipal housing authority had before they decided to provide smokeless fuel burning apparatus in the houses they erected was the shortage of supplies at a reasonable price. It was known that bituminous coal was used by some of their tenants in apparatus designed for smokeless fuel with unsatisfactory results. Another point was the availability of smokeless fuels in large industrial areas where smoke from coal fires had the greatest harmful effect. With the present shortage of smokeless fuels would it be possible to arrange that such fuels should be more readily available in congested areas and not encouraged in rural areas where the smoke from coal fires was quickly dispersed with little danger of a high air pollution? Price was vitally important for municipal housing tenants. Gasworks coke was high in price, no doubt to keep down the price of gas. Coke at a cheaper price would encourage its use.

Alderman T. M. Larrad (Manchester) said that as a member of the Manchester Health Committee, which was responsible for a smokeless zone which had been in operation for the past eighteen months so successfully that they were seeking powers to extend it to twice its present area, he was very interested in the availability and the price of smokeless fuel. They had in their housing estates many thousands of houses fitted with modern grates capable of burning solid fuel smokelessly. They had no desire to make these compulsory smokeless zones, but had embarked on a publicity campaign to secure the voluntary co-operation of every resident in the area. The co-operation of the local community associations, churches, chapels, gardening associations, etc., had been sought, and obtained, and they were hoping by this means to establish voluntary smokeless areas in districts where there was little or no industrial pollution. But its success depended almost entirely on the availability and reasonable price of solid smokeless fuels. They must be as readily available as coal at a price that would compare favourably with the present price of household coal. They had been assured locally that coke and other solid fuels would be available and preference would be given to areas where this experiment was being made. But in these days of rising costs, price was an important factor and the Gas Board might seriously consider a reduction in the price of coke for household purposes.

E. J. Winfield (Castleford) said he was a practising sanitary inspector and also had the honour to be Chairman of the West Riding of Yorkshire Regional Smoke Abatement Committee. He hoped his remarks would not only be of interest but would also reassure both conference and Mr. Wilkinson that sanitary inspectors did in fact take a great interest in smoke abatement.

The papers that afternoon were devoted to smokeless solid fuels. It was the aim and object of all interested in smoke abatement to have such materials supersede the use of bituminous coal. There were many aspects to the problem, but the discussion seemed only to be skirting the greatest problem of all—cost. One speaker had already suggested that their propaganda should be directed towards the housewife rather than her husband, to which he heartily concurred. He said that if they were to succeed in increasing the use of smokeless fuels they must have the support of the lady of the house, and she could be persuaded by financial inducement. In his opinion the current price of coke, etc., was the greatest drawback to its use.

Mr. Winfield said that before leaving for the conference he had secured the ruling prices of fuels in his town. He found that the eight grades of coal fell from 110s. 2d. down to 60s. 2d. per ton or 5s. 7d. per cwt., down to 3s. 1d. per

cwt. Gas coke was 99s. 9d. per ton or 5s. 2d. per cwt., and Coalite was 135s. 8d. per ton or 6s. 10½d. per cwt., plus 1d. for bagging. The coal prices were basic and were subject to a 5s. per ton decrease in the summer period and a 5s. increase in winter. Coke prices were static throughout the year.

Accepting that coke was lighter by weight and gave an increased bulk there was no inducement to housewives to turn from coal. He said there must be more tangible arguments. Commercial undertakings had realized that the housewife needed financial stimulus; even the mere men who were present would not be ignorant of the method employed to persuade housewives to purchase soap powders, namely the distribution of vouchers which could be cashed when purchasing the product. Some similar incentive was needed in their arguments with housewives.

An equally serious problem was the installing of modern solid fuel appliances. Many had already been installed but were essentially in houses owned by the occupier or owned by local authorities. What of the vast number of "rented" houses? Tenants were not prepared to spend £5 or more installing a modern fireplace in someone else's house. Equally so landlords were not prepared to spend money installing firegrates which gave them no personal benefit. How then could they be secured? The member from Salford had raised the desirability of paying grants; the Housing Act, 1949, had also been mentioned, but his fellow sanitary inspectors would agree with him that this Act had been stifled by its own restrictions.

When this country sought to abolish that menace to health, the privy midden, legislation was produced which gave power to local authorities to meet half the cost of conversion, and Mr. Winfield suggested that such procedure could be applied to fireplace conversions and so assist in securing the appliances which were so complementary to smokeless fuels.

Mr. G. E. Hall said in reply to the discussion that he was very pleased to be able to speak for the Solid Smokeless Fuels Federation on this occasion, but since he had been associated with the production of one of the papers only, he would confine his remarks to the subject matter of that paper. He thanked the many speakers collectively for their encouragement and criticism and felt sure that the discussion would prove a valuable addition to the transactions.

Both Mr. Taylor and Mr. Winfield had raised the all important question of the cost of replacement of domestic appliances unsuited to the burning of solid smokeless fuels. Mr. Taylor had stated that this "was the biggest obstacle to smokeless zones" and there were many who held this view. Mr. Hall agreed that this was certainly one of the obstacles but differentiated between private and Local Authority property. For the former special arrangements would have to be made and in the case of Salford, the Gas Board had offered special deferred payments terms. Where the Local Authority were the landlords borrowing powers already existed and many were taking advantage of them to modernize the domestic appliances and also amenities of the older property. A number of examples had been given in the paper. There was quite a move in this direction at present and this move had been given the name "operation rescue." Mr. Taylor was quite right in stating that many of the older appliances will burn solid smokeless fuels. This emphasized the need for an inventory of appliances in the proposed smokeless zone and of advice to the householders regarding their appliances. Sight should not be lost of the improved efficiency and convenience of the modern appliances and the longer life of furnishings, decorations etc., when burning solid smokeless fuels. In 1952 some 2¼ million users considered these advantages worth the cost of the new appliance.

Mr Hales had referred to the reduction of sunlight through "smog." This was undoubtedly a big factor not only from the standpoint of the health of the community, but also because solar radiation could help substantially to reduce the amount of fuel required to heat one's home. One of the reasons advanced for the reduced fuel usage per house in America was that the hours of sunlight were longer than in this country. The estimate of appliance efficiency had been based on the statement of J. C. Weston referred to in the paper. Most of the appliances would have back boilers and only a few intermittently used appliances could be of the simple open fire type. They all agreed that appliances of the highest efficiency should be used and that at present these were of the convector open fires and openable stove types.

Mr. Hall thanked Mrs. Charlton for her encouraging remarks and regretted that

mention had not been made in the first paper of the very valuable work of the Women's Advisory Council on Solid Fuel. Such mention would be made when the papers were printed in their final form in the transactions of the Society.

In reply to Mr. Wilkinson, Mr. Hall said that the Coking Industry was well aware of its own shortcomings but he felt that one or two of Mr. Wilkinson's statements were even so rather highly coloured. To rate coke ovens as having the highest nuisance value per ton of coal of all industrial fuel using appliances was quite frankly wrong. Whilst it was admitted that particularly at older plants smoke was emitted on charging the ovens, astronomically large tonnages of coal were processed and the amount of smoke emitted per ton was in fact quite slight. Mr. Hall did not consider that the recommendations made by the British Coke Research Association in 1946 were either punitive or in some particulars being discredited now; in its building programmes the Industry was following the recommendations. He felt that the double collecting main now being installed on all new plants was a considerable step forward in reducing smoke emission and was surprised that Mr. Wilkinson from outside the Industry should cast doubt upon its efficacy. He added that the Industry was particularly concerned about problems of atmospheric pollution and work was continually going on behind the scenes to deal with these matters. With regard to coke quenching, experiments were being conducted with different types of water sprays with a view to shortening quenching times, but it seemed necessary to point out that quenching towers did not emit smoke but water vapour. The dry coke cooling processes were, of course, effective, and there was no smoke emission but it was difficult to justify their general adoption on account of the high capital cost involved.

Mr. J. O. Cooke, in reply to the discussion, also thanked the speakers for their contributions, which seemed to centre around the availability and cost of coke in the domestic market and the steps being taken to encourage its use.

The second paper dealt fully with present and potential future availability There was no doubt, given the will, that considerably larger quantities of solid smokeless fuels could be made available to domestic consumers not only by increases in production, but by switches of domestic sized smokeless fuel now being supplied to non-essential markets. The paper showed how this could be done. The Federation fully supported the development of smokeless zones and it was proposed that the diversion of existing supplies of non-domestic solid smokeless fuels to domestic markets should take place concurrently with the establishment of these zones in high smoke pollution areas.

On the question of relative cost of cokes and other solid smokeless fuels, the real issue was the relative cost of the output of useful heat into the room. The paper clearly showed that weight for weight coke had a very considerable advantage. In fact, in no part of the country could it be seriously argued that bituminous coal was cheaper than coke when used in suitable domestic appliances.

The modern coke fire burning 14 hours a day seven days a week, consumes about 1¼ cwts. of coke per week, and gave out in doing so more heat than would be given out in burning 2 cwts. of bituminous coal. This, coupled with its cleanliness in operation, and if gas ignition were fitted its saving of labour and drudgery to the housewife, would surely be sufficient incentive to encourage householders to use it. These were the facts that must be brought home to the users.

The supplying industries were still working under the restrictions and frustrations of rationing but were fully alive to their responsibilities. The Federation was taking an active part in educating users by participating in fuel efficiency and building trades exhibitions and for the last three years had maintained a travelling mobile exhibition which had covered a large part of the country. This education work was being continued and intensified in the coming year both by the Federation and by its individual members.

THE EFFICIENT AND SMOKELESS COMBUSTION OF FUEL OILS

by

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Introduction

Fuel oil is generally accepted as being a smokeless fuel and hence whilst a great deal of investigation has been carried out into the smoke produced from coal burning appliances comparatively little attention has been given to this aspect of fuel oil burning. In referring to fuel oil as a smokeless fuel, we mean, of course, that when burned in properly designed apparatus under normal conditions no visible smoke is emitted from the chimney. It is, however, possible to produce very considerable volumes of smoke from fuel oil, whilst to avoid smoke production and at the same time to obtain a high combustion efficiency demands a certain standard in the design of the apparatus and its maintenance, also if manual control is relied upon, a modicum of skill on the part of the operator. Where these elements are lacking, the plant is generally still operated so as to avoid visible smoke formation but at a reduced efficiency, consuming more fuel than is really necessary for the duty to be met.

The two major problems in fuel utilization today are conservation of fuel resources and reduction of atmospheric pollution. In the succeeding sections it is hoped to show to what extent these desirable objects are achieved in the burning of fuel oils, to indicate standards of cleanliness and efficiency which should be attained by any well designed and well maintained oil burning plant, and to summarize, briefly, possible causes of sub-standard performance.

Characteristics of Fuel Oils

Table I gives the properties of typical samples of the three grades of

TABLE I

Approximate Average Analyses of Typical Samples of Domestic Fuel Oil (Gas Oil), Medium Fuel Oil and Heavy Fuel Oil, as marketed in the United Kingdom

	Domestic Fuel Oil	*Medium Fuel Oil*	*Heavy Fuel Oil*
Specific Gravity at 60° F./60° F. ..	0.835	0.930	0.960
Flash Point P.M., c.c., °F.	170	200	210
Viscosity, Redwood I @ 100° F., seconds	34	200	900
Total Sulphur, % wt.	0.85	3.0	3.5
Ash, % wt.	Negligible	0.03%	0.05%
Calorific Value, gross, B.T.U./lb. ..	19,600	18,900	18,700

fuel oil marketed in this country, namely:

Domestic Fuel Oil (Gas Oil).
Medium Fuel Oil.
Heavy Fuel Oil.

Broadly speaking, the application for these three grades is as follows:

Domestic Fuel. Small fully automatic domestic oil burners having capacities up to 3 or 4 g.p.h.

Industrial oil burners of small capacity where the cost of preheating the heavier fuels would be unjustified.

Certain processes where the products of combustion come into contact with the material being heated and where the product is such that it is essential that the combustion gases should be as free as possible of ash or other solid matter.

Medium Fuel Oil. The medium fuel oil is used for the larger automatic oil burners and for industrial applications where the cost of preheating is justified but where from considerations of the size of the individual burners or the nature of the process it is not desirable to utilize Heavy Fuel Oil.

Heavy Fuel Oil. Heavy Fuel Oil is used for such applications as steam raising in both land and marine boilers and for industrial applications where the consumption involved and the capacity of the individual burners is sufficient to warrant the cost and complication of the necessary preheating of the fuel before burning.

The influence of these fuel characteristics will be dealt with in considering the methods by which fuel oil is burned in practice.

Combustion of Fuel Oil

Apart from very small proportions of impurities, petroleum fuels consist entirely of hydrocarbons—compounds of the two chemical elements carbon and hydrogen and the requirements of combustion consist in providing favourable conditions for these two elements to combine with the oxygen in atmospheric air to form, in the case of carbon, carbon dioxide (CO_2) and in the case of hydrogen, water vapour (H_2O).

The favourable conditions referred to are:

(1) A sufficient supply of air.
(2) Intimate contact between the fuel and the air.
(3) A zone of high temperature which stimulates the elements to rapid and complete combination.

The first and third of these conditions are not difficult to meet. Air is plentiful and cheap. Ignition having been established, the high temperature zone is supplied by the flame itself, providing that it is not cooled too rapidly.

It is in meeting the second condition—the intimate contact between fuel and air—that the art of the combustion engineer is chiefly directed, his object being to obtain such thorough mixing that, with little more than the theoretically necessary air quantity, every particle of the fuel is completely consumed in the short time (usually less than one-third of a second) in which the mixture remains in the combustion chamber where the temperature is sufficiently high to support the combustion process. This is the crux of the problem of burning fuel with maximum efficiency and with the minimum of unburnt residue in the products. That for the highest efficiency the excess air should be kept to the minimum is apparent when one considers that, after coming into contact with the material or surfaces they are designed to heat, the combustion gases must eventually pass into the chimney and any heat still contained in them is wasted so far as the useful heating process is concerned. The temperature of the gases when they reach the chimney is dependent on the design of the heating apparatus which may have a larger or smaller heating surface in relation to the quantity of heat to be absorbed, dependent on the relative importance of thermal efficiency, capital cost, space occupied, etc. The weight of gas passing up the chimney per unit weight of fuel burned is, however, the sum of the unit weight of fuel and the

eight of air required to burn it. For
ample, to provide 10 per cent.
cess air, in theory a fuel oil requires
proximately 16 lbs. of air per lb. of
el. In this case, 17 lbs. of combus-
on gases are formed. If, however,
) per cent. excess air is supplied, that
to say, 22 lbs. of air per lb. of fuel,
en the weight of combustion gases
23 lbs. and at the same chimney
mperature the heat loss to the
imney will be increased in the ratio
f 23 : 16, an increase of some 44 per
ent. For reasons which cannot be
iscussed here, the supply of excess
r to the flame, while resulting in a
wer theoretical flame temperature,
oes not as a rule reduce the tempera-
ure of the gases entering the chimney.
n fact, the temperature at the
imney is increased when more
xcess air is supplied. This results in
urther loss both on account of tem-
erature and of quantity of gas passing
the chimney per lb. of fuel.

tack Solids

As the excess air is reduced a point
reached where some of the fuel can
o longer find sufficient air to com-
lete its combustion whilst it is still
a zone of sufficiently high tempera-
ure.

Except under special conditions fuel
ils burn with a luminous flame. This
uminosity is due to the presence in the
ame of a very large number of
xtremely small particles of carbon
roduced by the cracking of the
apour distilled from the fuel. In
he presence of oxygen, and if main-
ained at a sufficiently high tempera-
ure, these particles burn to carbon
lioxide.

When burning the heavier grades of
uel oil cracking of the fuel in the
iquid droplet stage may also occur
nd give rise to the formation of
arger particles composed of carbon
nd ash, and often having the form of
hollow sphere of lattice construction.
These are, as it were, the skeletons of
he original droplets of the atomized
spray after the lighter fractions have
een distilled off and the heavier
esidue cracked with the emission of further light products, leaving behind the carbon and ash. Here again, given the necessary conditions of temperature and oxygen supply the carbon can be consumed, leaving only the incombustible ash.

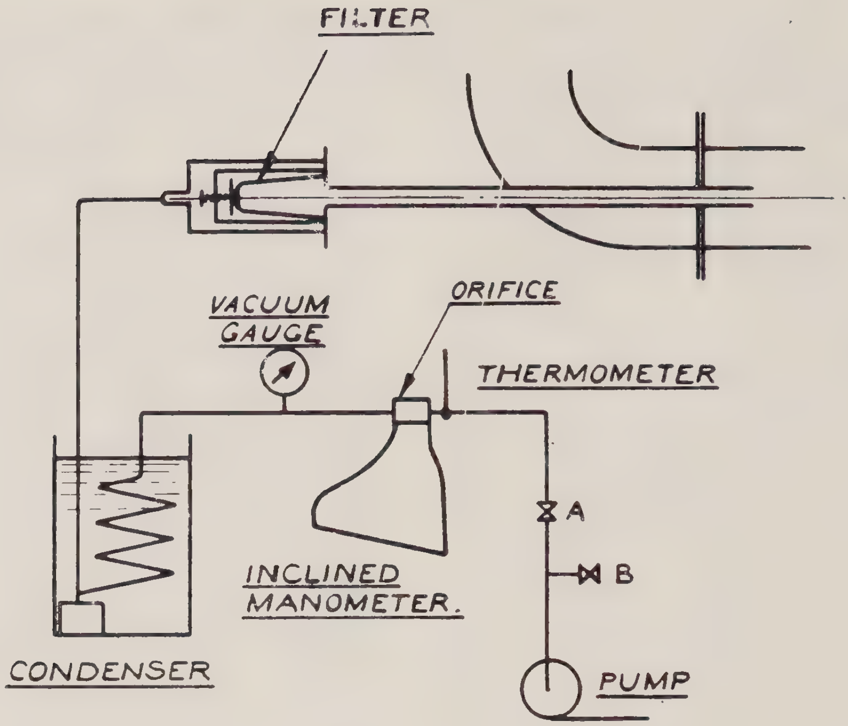
Particles of both types, in which the carbon is not completely burned before they escape from the zone where the necessary conditions exist for continued combustion together with particles of ash, are given the name of "Stack Solids." At normal concentrations they may be quite invisible to the naked eye, and it is only when, due to poor combustion conditions, they have reached the concentration visible to the eye, that they can reasonably be termed "smoke." The concentration of stack solids necessary to produce visible smoke has been assessed by methods which will be described in the following section.

Methods of Smoke Detection and Measurement

Apparatus for the measurement of the stack solids in combustion gases has been developed using three different principles:

(*a*) Filtration and weighing.
(*b*) Filtering the combustion gases through paper and measuring the discoloration produced,—either by matching visually against a standard chart or by optical means.
(*c*) Measuring the degree of light obstruction or reflectance produced by the stack solids.

Of these three methods the first has the advantage of being an absolute rather than a comparative measurement but, in general, is a tedious procedure and a test occupies a considerable time. One apparatus of this type is shown diagrammatically in Fig. 1. The filter consists of a thimble of alundum through which the combustion gases are drawn by a vacuum pump. An orifice gauge is used to control the sampling rate and the readings are integrated to give the total volume drawn through the filter. With this particular apparatus, 80 cu. ft. measured at 60°F. 30 in. Hg



APPARATUS FOR MEASURING SOLIDS CONTENT OF FLUE GAS.

Fig. 1

is drawn through the filter over a period of one hour. At the completion of the tests the filter is placed in a desiccator and, after cooling, is weighed and the increase in weight noted. Since the weight of deposit compared with the weight of the filter is small, great care has to be taken in order to obtain accuracy. The method, though cumbersome, gives results which are closely repeatable, and is used to calibrate the comparative methods. In another apparatus designed by B.C.U.R.A., the combustion gases are drawn through a narrow annulus between a cylindrical heating element and an outer sheath of aluminium foil. The stack solids are deposited on the surface of the foil by thermo-repulsion. The aluminium sheath can be removed from the apparatus and the deposits weighed and examined. The advantage of this method over that previously described is the low tare weight of the deposition surface which simplifies accurate weighing.

Fig. 3 shows diagrammatically an apparatus developed by the Shell Oil Company in the U.S.A. for the rapid assessment of stack solids. A small motor-driven vacuum pump draws a sample of the combustion gases through a disc of filter paper for a period of one minute, the pressure drop across the paper being maintained constant at 3 in. Hg. The filter paper is then removed and the discoloured spot matched against a " comparator " scale which consists of a number of circles having shades graduated from 0—white to 9—black. The nearest matching shade is designated as the Shell Smoke Number. A Shell Smoke Number of 6 represents the lowest concentration of stack solids which is just visible at the chimney under favourable conditions. Thus, one can distinguish between 5 shades or 10 half shades of " smoke "

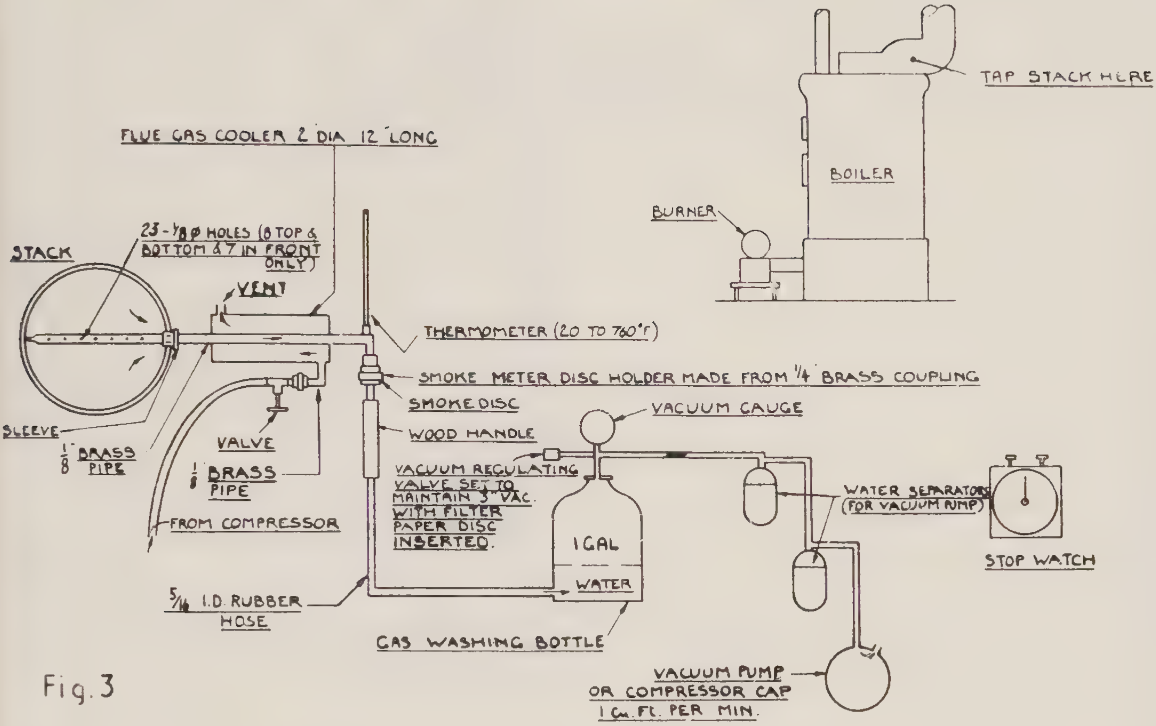


Fig. 3

below the least which is visible to the naked eye. This instrument is available commercially in the United States as a portable instrument for field use in two forms, one with a motor-driven vacuum pump and automatic timing and gas volume regulation; the second in the form of a light hand pump of which ten full strokes give results identical with those obtained in the more elaborate instrument.

In smoke measuring instruments of the third type a beam of light is directed on to a photo-electric cell across a fixed thickness of gas. The reduction in the intensity of the light over that passed by an equivalent thickness of pure air is indicated by a reduction in voltage produced by the photo-electric cell and its associated equipment and serves as a measure of smoke intensity. This type of instrument has the advantage of giving instantaneous response to changes in smoke value but suffers from the disadvantage of very variable sensitivity according to the density of the smoke. Fig. 4 shows the readings of a photo-electric type plotted against Shell Smoke Numbers, and it will be seen that there is very little change in the reading of the photo-electric instrument below the commencement of the visible smoke range, i.e., a Shell Smoke Number of 6. By altering the sensitivity of the photo-electric device it can, of course, be made sensitive over any particular, but limited, range. Where it is desired to cover a large range the advantage lies with the filter paper method.

Generally speaking, the first method, that of filtering and weighing, is only suitable for laboratory use. Instruments employing filtration and colour matching are available in portable form, and probably form the most satisfactory device for field testing and for taking spot readings. The photo-electric type is best suited for permanently installed boiler-house instruments where qualitative indication only is required.

Test Results

To assess the efficiency of a fuel oil burner, i.e., its ability to achieve complete combustion of the fuel with the minimum quantity of excess air, the two essential measurements are:

(*a*) CO_2 content of the flue gases as a measure of excess air.

(*b*) Stack solids content as a measure of completeness of combustion.

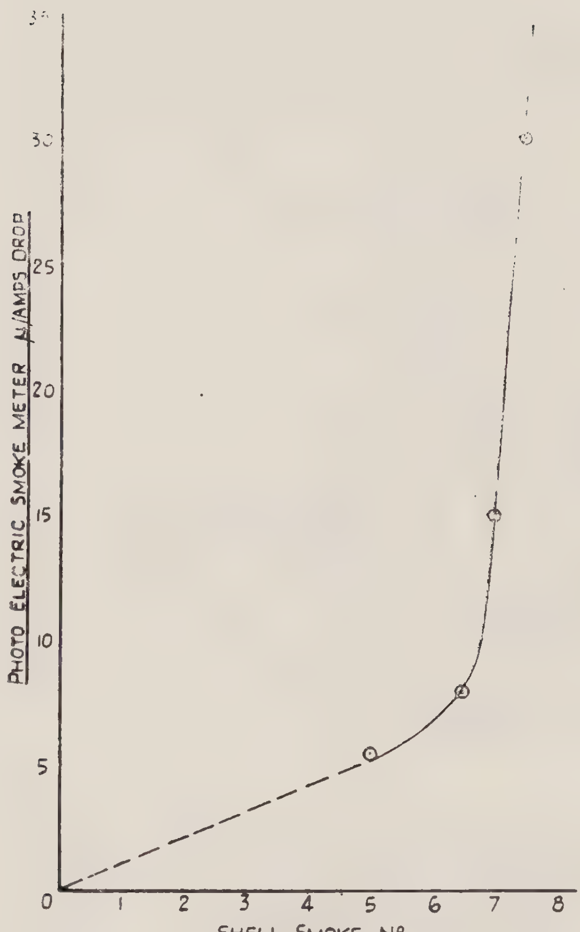


Fig. 4

Given these two figures the performance of the burner may be expressed in terms of the highest CO_2 content (lowest excess air ratio) which can be employed without exceeding a certain smoke measurement. In burner tests carried out at the Shell Laboratories the maximum permissible smoke is fixed as No. 5 on the Shell Smoke scale, which is, roughly, one smoke number less than that at which visible smoke can just be detected at the chimney. What this means in terms of stack solids is shown by the correlation curves in Fig. 2, the weight of stack solids having been determined by the alundum filter method. It will be seen that the correlation between stack solids and smoke number for the heavy grades of fuel is very different from that for the distillate fuel (Domestic Fuel Oil or Gas Oil), the former giving 5 to 12 times the weight of stack solids with the same smoke number. Thus, the permissible limit of smoke number 5, corresponds to a stack solids content of 0.015 grains/cu. ft. when Domestic fuel oil is burned, and approximately 0.10 grains/cu. ft. when burning the heavier fuel oils. This discrepancy is a feature of optical methods of smoke measurement and is caused by the different types of particles produced from the light and heavy fuels respectively. In the case of the light distillate fuels, the majority of the free carbon formed during combustion arises from cracking of fuel oil in the vapour state. In the case of the heavy fuels which do not vaporize completely below their cracking temperature, cracking in the liquid state also occurs, giving rise to a proportion of larger particles, as already explained.

In the filter paper method of assessment by colour matching, a certain shade of grey is produced when a definite proportion of the white paper is covered by more or less black particles. It is, therefore, the area of the particles and not their volume which determines the shade produced, and for a certain percentage of black to white larger particles will produce a larger volume of deposit on the paper. In theory, therefore, one might expect that for a given shade of grey the weight of deposit would be proportional to the diameter of the particles. Actually, however, the filter paper does not have a completely smooth surface but consists of a mat of fibres in which the finer particles are embedded and, also, the larger particles have, as a rule, a hollow structure and a lower apparent density.

Logically, one should permit a higher smoke number when burning a light distillate fuel than when burning heavy fuel. To do so, however, would either mean tolerating with distillate oil burners operation in the visible smoke range, or reducing the permissible smoke number with heavy fuel oil burners to a value which would be difficult to attain with a reasonably low percentage of excess air. In this connection, it should

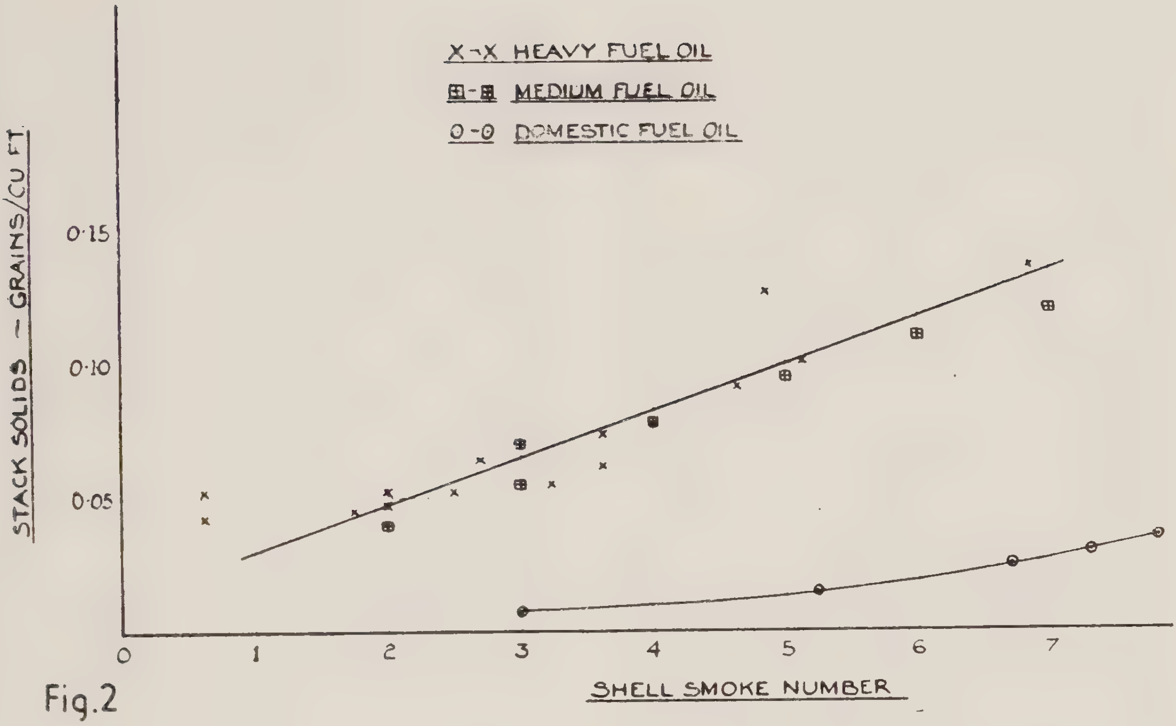


Fig.2

also be borne in mind that the heavier residual fuel oils contain small but appreciable quantities of ash which add to the stack solids represented by any unburnt carbon.

The relationship between the weight of stack solids and the Shell Smoke Numbers is not quite linear but for heavy fuel oils the deviation is within the limits of accuracy of the method. For solids produced by the combustion of a distillate fuel, however, a better approximation is given by the formula:

$$\text{Shell Smoke No.} = 6.85 \log_{10} \left(\frac{\text{grains}/1000\ \text{ft}^3}{2.4} \right)$$

For the subject under discussion in this paper it is perhaps better to express the stack solids in the combustion gases as a percentage by weight of the fuel burned. The volume of the flue gas produced per lb. of fuel will, of course, depend upon the quantity of air supplied for combustion and, therefore, on the CO_2 content of the flue gases. For petroleum fuels, the volume of flue gases is given approximately by the formula:

$$\frac{2700}{CO_2\%} + \begin{matrix} 24 \text{ for light fuel oils} \\ 22 \text{ for heavy fuel oils} \end{matrix} \quad \begin{matrix} \text{cu. ft./lb. at } 60^\circ\text{ F.} \\ 760 \text{ mm. Hg.} \end{matrix}$$

Applying this to the correlation curves given in Fig. 2, and assuming that a CO_2 content of 11 per cent. can be obtained in the case of both fuels with a Shell Smoke Number of 5, the amount of stack solids expressed as a percentage of the weight of fuel burned is:

For distillate fuel .. 0.06 per cent.
For heavy fuel oil .. 0.38 per cent.

The above figures represent what may be regarded as the lower limit of acceptable performance for first class oil burning systems. They by no means represent the optimum that can be obtained. Indeed, we have on occasion when burning gas oil in our laboratories, particularly under conditions where a fairly high percentage of excess air is permissible, obtained a Shell Smoke Number of zero, whereas the laboratory air gave a definite smoke shade approximately to No. $\frac{1}{2}$ on the Shell smoke scale. This may seem more credible when it is explained that our laboratory is situated in close proximity to two Power Stations and adjoining a large gasworks. Again, when burning heavy fuel oils in our stack solids measuring apparatus, we generally maintain as a matter of convenience, a CO_2

content of 12 per cent., corresponding to approximately 30 per cent. of excess air, and have no difficulty in obtaining Shell Smoke Numbers less than 2, corresponding to 0.2 per cent. by weight of fuel consumed.

Table II shows the results of some measurements of stack solids carried out on two industrial boiler plants using pressure jet oil burning equipment having well designed air control. It will be seen that the stack solids in the flue gases represent only from ¼ per cent. to less than ½ per cent. of the weight of fuel burned. Tests 1 to 4 comprising measurements at various boiler loads illustrate the fact that the stack solids as a percentage of the fuel burned may be higher at partial loads than at full load. The reason for this is that the air control is designed to pass the air required under full load conditions and at partial loads the quantity of air and therefore its velocity into the furnace is reduced, creating less turbulence and less thorough mixing of the air and fuel.

Tests 5 to 8, all carried out at the same boiler load clearly show how, as excess air is reduced, the stack solids are increased. The increase in stack solids from 0.24 to 0.39 per cent. represents an almost negligible loss in the heating value obtained from the fuel whereas a considerable saving is achieved by reducing the excess air from 59 per cent. to 12 per cent. A further reduction to 3 per cent. excess air as shown in Test 8 brings the quantity of stack solids into the region where visible smoke is just apparent and it will also be noted that a small additional proportion of the carbon is only partially burned to carbon monoxide. This gradual increase in CO_2 content and stack solids, as the excess air is reduced, combined with the ability to operate with only 3 per cent. excess air and yet produce only very light smoke and only 1 per cent of CO in the flue gases is an indication of very good air regulation and mixing.

In Fig. 5 the results of Tests 5 to 8 are shown in comparison with those obtained in tests at the Fuel Research Station on a hand-fired Lancashire boiler burning bituminous coal. (F.R.S Technical Paper No. 53). Whilst no exactitude can be claimed for this comparison owing to the different nature of the stack solids, it shows that the stack solids produced from

TABLE II

Test No.	*Approx. Boiler Output lb./hr.*	*Flue Gas Analysis % Dry Flue Gas*			*Excess Air %*	*Shell Smoke No.*	*Stack Solids*	
		CO_2	*O_2*	*CO*			*Grains per cu. ft.*	*% Fuel wt.*
1	2,000	10.2	7.6	0	51	5½	0.110	0.43
2	5,300	12.0	—	—	30	5½	0.110	0.39
3	8,000	12.4	4.5	0	26	4½	0.090	0.31
4	8,000	11.7	5.5	0	33	3	0.065	0.23
5	4,800	9.7	8.0	0	59	3	0.065	0.24
6	do.	12.4	4.5	0	26	4	0.082	0.28
7	do.	13.4	2.7	0.5	12	5	0.100	0.31
8	do.	14.2	1.3	1.0	3	7	0.135	0.39

Tests 1-4 Sinuflow Economic Type Boiler.
Rating 9,000 lb. steam/hr.
Single furnace.

Tests 5-8 Economic Type Boiler.
Rating 8,000 lb. steam/hr.
Double furnace.

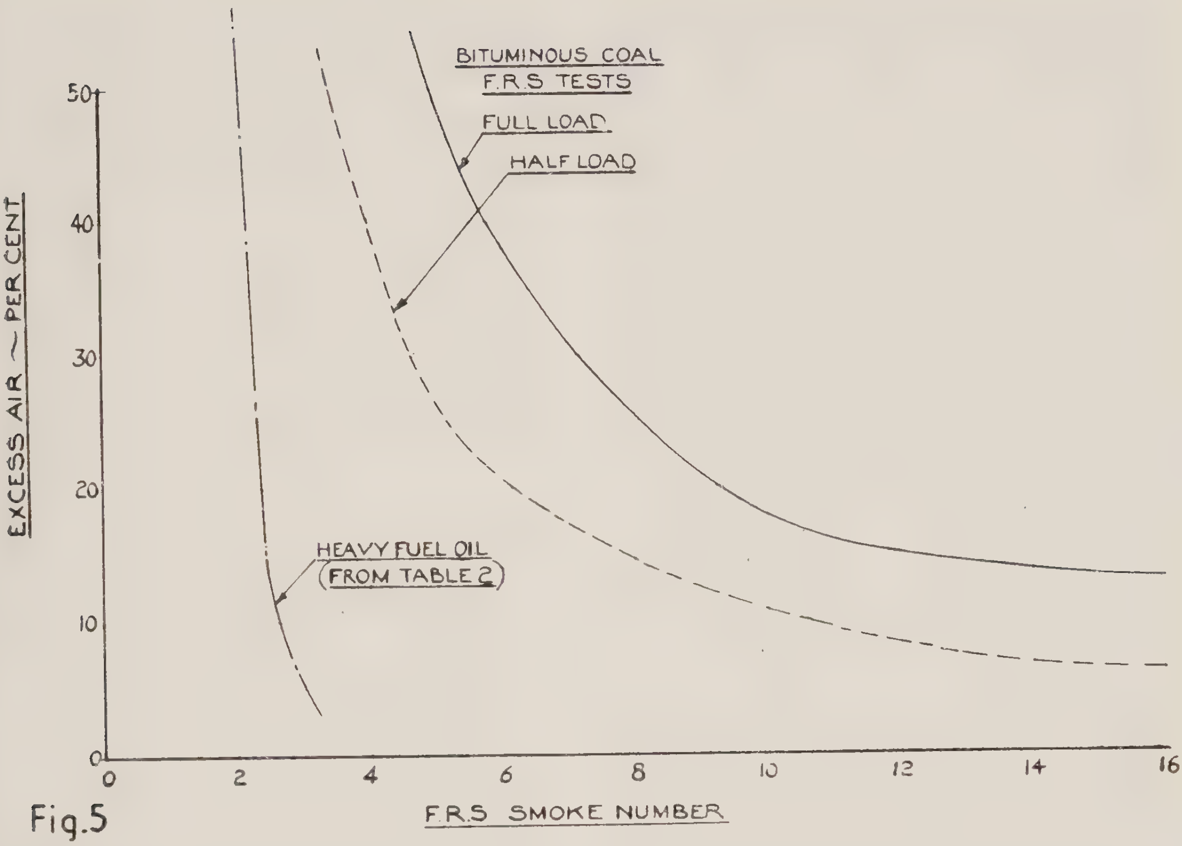


Fig.5

oil fuel are considerably less than those from bituminous coal at all excess air quantities below 60 per cent. and that with oil fuel the excess air can be reduced to less than 10 per cent. without giving rise to visible smoke. With bituminous coal the stack solids were above the lower limit of visible smoke at all values of excess air below 60 per cent. and increased very rapidly as the excess air was reduced below 20 per cent. The higher emission of stack solids from bituminous coal is partly due to the higher ash content. If the ash in the combustion gases is deducted the curve for full load conditions coincides approximately with that shown in the graph for total stack solids under half load conditions. It will be seen that the stack solids due to incompletely burnt conbustible matter in coal is still very much greater than the total stack solids from Heavy Fuel Oil.

Since for a given heat input and excess air ratio, the volume of combustion gases is approximately the same for fuel oil as for bituminous coal, the comparison (with the reservation mentioned above) also holds for the total quantities of solids emitted for the same heat input. In support of this comparison between the results of the F.R.S. tests and those on fuel oil it may be noted that a Shell Smoke No. of 6, which roughly represents the lowest limit of visible smoke, corresponds, with Heavy Fuel Oil, to a stack solids concentration of 7.7 gram./1,000 cu. ft., approximately equivalent to F.R.S. Smoke No. 3. This number is given as the lower limit of light grey smoke from bituminous coal and the two methods are therefore in close agreement at this concentration.

Surface Deposits

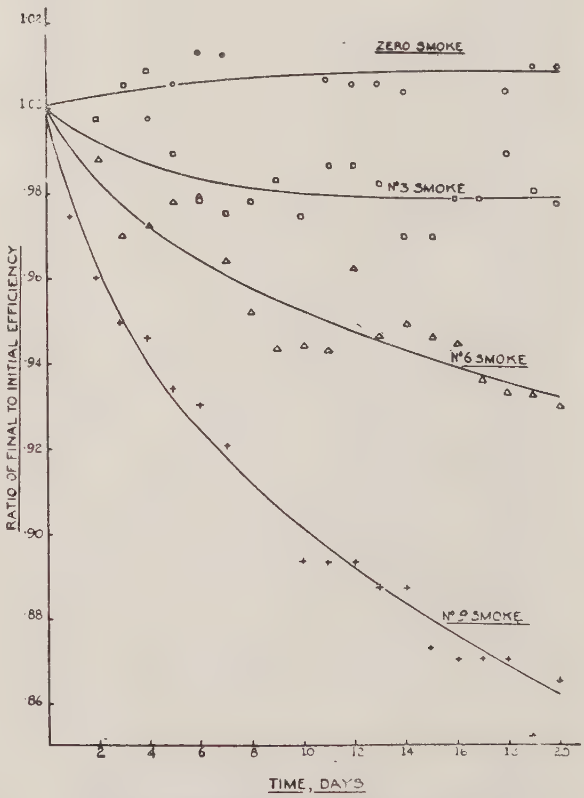
From the point of view of atmospheric pollution, it is only those stack solids which are carried out from the chimney by the combustion gases which come into consideration. Apart from these gas borne solids, however, imperfect combustion may cause carbon deposits in the combustion chamber or on the heating surfaces of the boiler. Deposits in the combustion chamber are generally

caused by an imperfectly atomized fuel spray or a spray of unsuitable shape striking the surfaces of the combustion chamber where, depending on the nature of the fuel and the temperature of the surfaces, they may distil or crack, and in the latter case leave behind a residue of hard carbon which, due to its compact nature and situation, is in an unfavourable condition for combustion. Carbon deposits caused by spray impingement will generally burn away slowly providing that the surface on which they are formed is sufficiently hot and that the necessary oxygen is present. During operation, however, once a deposit is formed, it increases the amount of impingement and the deposit forms more rapidly than it burns away.

With atomizing burners the whole of the oil should be in suspension and hard carbon deposits of the type described above should not occur unless the atomization is poor or the burner is giving too wide a spray angle for the width of the combustion chamber. In vaporizing burners however, the fuel is gasified by bringing it into contact with a hot surface generally maintained at the requisite temperature by heat radiated or conducted from the flame. In order to avoid the accumulation of hard carbon deposits in this class of oil burner it is essential that the temperature of the vaporizing surface shall be limited by correct design, so that it is sufficient to vaporize the fuel but below the temperature at which the fuel cracks. Conversely, this class of burner is restricted to a fuel which can be completely vaporized at a temperature below that at which any appreciable cracking occurs. The tendency of a fuel to crack and leave behind carbon deposits when vaporized by heating is indicated by the Conradson test in which this process is carried out under standard conditions. The medium and heavy fuel oils give appreciable Conradson carbon values but the figure for gas oil is very low. The heavier fuels are therefore unsuitable for use in vaporizing burners. It should be emphasized that the conditions of the Conradson test are quite different from those under which the combustion of fuel oil in atomizing burners takes place and the fact that a fuel has a Conradson carbon content of say 6 per cent. does not mean that 6 per cent. of the fuel will be unconsumed on burning. There is in fact no correlation between Conradson carbon content and the stack solids remaining after combustion.

Deposits on heating surfaces of boilers or other forms of heat exchanger result from some of the gas borne stack solids falling out of suspension. Their effect is to increase the resistance to heat transmission of the heating surface and thus lower the efficiency of the apparatus.

Fig. 6 summarizes the results of a series of tests carried out at the Oil Burner Laboratories of the Shell Oil Company, U.S.A. to determine the effect on the efficiency of a domestic boiler of oil burners operating with



EFFECT OF SMOKE DENSITY IN THE FLUE GAS ON CHANGE IN EFFICIENCY

Fig. 6

various degrees of smoke as measured by the Shell Smoke Meter. It will be seen that after a period of 20 days with a No. 3 Smoke Number the efficiency of the boiler has been reduced by only 2 per cent of its original efficiency, whilst No. 6 Smoke Number resulted in a drop of 6 per cent. and the No. 9 Smoke Number of 14 per cent. of the original figure.

In the above tests, a light distillate fuel was used. As already mentioned, when burning heavy fuel oils the weight of stack solids for a given smoke number is several times greater than when burning a light distillate fuel and one would expect, therefore, that if the above tests were repeated using heavy fuel oil, the drop in efficiency due to the accumulation of surface deposits would be much more rapid. Although it has been shown that with first-class oil burning equipment it is possible to use as little as 10 per cent. excess air without producing visible smoke, the gain in efficiency as compared with burning with 15-20 per cent. of excess air may well be nullified by the reduction in heat transmission due to more rapid fouling of the heating surfaces.

Gaseous Products

The main gaseous products of combustion from petroleum fuels when burned with excess air are nitrogen—oxygen—carbon-dioxide and water vapour. These are all colourless, odourless, non-poisonous gases already naturally present in the atmosphere. Of the minor constituents, the most important from the point of view both of plant operation and atmospheric pollution are oxides of sulphur arising from the combustion of the sulphur in the fuel which as will be seen from Table I may vary from less than 1 per cent in the case of Domestic Fuel Oil (Gas Oil) up to about 3½ per cent. in the case of Heavy Fuel Oil. In comparing these sulphur percentages with those present in other fuels the comparative quantities of fuel used for a given duty must be taken into account. Depending on the application, fuel oil, on account of its high calorific value, the ease with which it can be controlled and regulated and the high combustion efficiency obtainable, may replace from 1½ to 2 or more tons of solid fuel. Hence a sulphur content of 3.5 per cent. in Heavy Fuel Oil is equivalent as regards the emission of sulphur dioxide for a given duty to a sulphur content of 1.75 per cent. to 2.3 per cent. in solid fuel.

Although a great deal of investigation has been carried out by oil companies on the possibility of removing sulphur in the refineries, no process has yet been discovered which will enable sulphur to be removed from fuel oils at anything like an economic cost. Some promising results have been obtained by introducing either into the fuel or the combustion chamber materials which will react with the sulphur products. These may solve the problem of sulphur corrosion in the plant but are likely to increase rather than reduce the amount of solid matter emitted from the chimney although possibly this may be less injurious in nature.

The fact that the combustion of oil fuel results in a very small proportion of solids being emitted may favour the dispersion of sulphur products into the upper air and thus reduce the probability of harmful concentrations in the atmosphere. This, however, remains to be proved.

The production of carbon monoxide from normal oil burning plants is extremely small and it is unusual to find more than about 1 per cent. of CO in the combustion gases even when the excess air has been reduced to a point giving rise to the production of visible smoke. Carbon monoxide, where present, is usually accompanied by about half its volume of free hydrogen.

Possible Causes of Smoke Emission

The three requirements for complete and efficient combustion of fuel oil have already been stated, namely, a sufficient air supply, rapid and thorough mixing giving intimate contact

between the fuel and the air, and a sufficiently high temperature maintained until combustion is complete.

The possible causes of smoke being produced by faults in installation or maintenance of oil burner apparatus will therefore be briefly summarized under the heading of these three requirements:

Insufficient Air Supply

Inadequate chimney or deterioration of induced draught fan.

Accumulation of deposits (a self-aggravating effect).

Air infiltration due to leaky doors or boiler settings.

Inadequate ventilation of the boiler room.

Failure to open air registers or increase air pressure *before* increasing oil supply.

Air controls should be maintained in good order so that they can be set quickly and accurately.

Uncontrolled fluctuating in fuel supply due to fuel viscosity (i.e., temperature) variations and/or unsuitable fuel control valves.

Where fuel rate is controlled by a valve as is usual in steam and air atomizing burners, the valve should always be of the " metering " type and protected by a filter having openings smaller than the opening in the valve at the minimum operating position.

Poor Fuel and Air Mixing (Fuel atomization and air control)

Bad atomization by worn or damaged nozzles (pressure jet burners).

Fuel supplied at too high viscosity (too low temperature) either due to poor temperature control or large and/or unlagged branch lines between point of temperature regulation and burner.

Atomizing agent pressure too low (air or steam burners) or excessive pressure losses in supply pipes.

Unsuitable choice of atomizing nozzle (pressure jet burners) giving either too wide a spray resulting in fuel impingement on furnace walls or too narrow a spray giving coarse atomization and heavy fuel concentration in the centre of the spray.

Fuel pressure too low (pressure jet burners). The smallest nozzle operated at the highest pressure should be used to meet a given load.

Parts of air director damaged—air cones—swirler vanes burnt away or distorted. Adjustable controls jammed.

Refractory quarls (brickwork throats) damaged or displaced.

Flame Chilling

Insufficient distance between burner and cold surfaces (e.g., in water tube boilers) in relation to burner type and output.

Large excess of air resulting in low furnace temperature.

In extreme cases this can lead to white smoke (unburnt oil vapour). This sometimes occurs in marine boilers when manoeuvring due to cutting out burners without reducing air register openings or air pressure.

Indirect mixing air heaters, admission of diluting air into combustion chamber or before combustion of fuel is complete.

Insufficient refractory around root of the flame.

Although the majority of atomizing burners will give clean combustion in a water cooled, unlined combustion chamber with only sufficient refractory to protect any uncooled surfaces, in some instances the provision of a small amount of refractory near the root of the flame materially assists rapid and clean combustion.

For certain high temperature furnaces, types of oil burners are used which do not produce stable flames in a cold environment. Attempts to use these oil burners before the furnace has been brought by other means to a temperature of perhaps 500°C. can give rise to smoke formation until working temperature is attained.

Smuts

A source of atmospheric pollution sometimes experienced is the sporadic emission of smuts which can occur

even where the stack solids in the flue gases are well below the visible smoke limit. The size of the average smut is very much bigger than that of the stack solids which can be filtered from the products of combustion, and it is reasonable to assume that these smuts are formed by the conglomeration of stack solids. These conglomerations may be formed when the combustion gases come into contact with the surfaces below their dewpoint, as for example, when warming up boilers or when unlined steel chimneys are used in conjunction with high efficiency boilers giving low flue gas temperatures. Since every gallon of fuel oil burned creates a gallon of water, any surfaces below the dewpoint of the gases become wet with condensed moisture and provide an excellent soot trap. When the temperature of the flue gases is increased as a result of increasing the boiler load or as the water temperature rises, surfaces which were previously damp may dry out and the conglomerations of soot break away and are carried out of the chimney as smuts.

The remedy is to pay particular attention to clean combustion during the warming up period and to the regular removal of deposits from boiler and chimney surfaces. In the case of steel chimneys the inside surface may be coated with a lining of insulating refractory such as vermiculite/cement mixture or where the flue gas temperatures are low they may be insulated externally and the insulation protected by light metal sheeting

Discussion

Sir Ernest Smith, opening the discussion, said that an important factor in the use of oil firing was the training of firemen particularly in the operation and manipulation of oil burners and the regular changing of jets. From the health point of view he was particularly concerned with the congestion of motor traffic, including buses, as in London, and the emission of carbon monoxide and exhaust gases from badly adjusted machines, especially during a still atmosphere and fog. He thought that it was likely that this was one of the causes of mortality during the London fog in December, 1952.

Dr. Parker said that dense clouds of black smoke could be emitted from the combustion of fuel oils in boilers and other furnaces, if the burners were not kept clean and they were not properly placed in relation to the furnaces, and if the arrangements for admission of secondary air were not entirely satisfactory. It was certain, however, that there was much less difficulty in securing smokeless combustion of fuel oil than with bituminous coals. An extension of the use of fuel oil in place of coal should therefore, tend to reduce the amount of air pollution by smoke. There was no doubt, however, one problem that required much more attention. This was the emission of smoke and deleterious gases from the exhausts of oil-fired diesel engines being used in an increasing number of road vehicles. In Dr. Parker's view much of the smoke from a number of these vehicles now on the road was due to bad maintenance of the engine and bad adjustment.

T. M. Ashford (Glasgow) associated himself with the observations of the previous speakers as to the importance and excellence of the subject matter presented by Mr. Sambrook. He said he would like to comment and emphasize on a number of the points already raised by the speaker.

It was true that there was a general conception by the public that fuel oil was a smokeless fuel and that in operation it gave smokeless results. This popular conception was quite wrong as fuel oil could only be so regarded in those aspects if it were skilfully and carefully made use of, both as regards the type and management of the plants concerned. In comparison with other solid fuels it could not be regarded as an entirely economical source of power or heating as in most cases the cost was in excess of solid fuel use. Convenience and availability were probably the primary considerations when oil

fuel installations were being adopted, these considerations involving the question of ease of installation, space occupied and rapid control, both as regards ignition and extinction. It also gave under proper control high efficiency.

Where those suitable conditions of plant and maintenance did not obtain then oil fuel could be a veritable smoke producer and of a very obnoxious nature. Many of the complaints handled by him in the course of his daily duties were the result of maladjustment in those plants. It was found that the main cause of trouble was lack of attention to the necessary heating temperatures of the oil and also excessive fuel admission to the burners, without corresponding attention to air admission.

In the majority of smaller installations it was the case that the executives in control and the operatives in attendance had been switched from solid fuel to oil fuel with only very perfunctory instructions and meagre training in the use of the plant and the fuel, and it was doubly imperative that such potential personnel should have an adequate training in the control of such plant before taking over duties. As was the case in other spheres of fuel burning, it was unfortunate that rule of thumb methods were allowed to persist with the all too frequent emission of noxious oily smoke and fumes.

Surely it should be the duty of the makers and contractors in such installations to see that both the executives and the operatives received a thorough course of instruction prior to the use of such plants. The advantages, convenience and efficiency of oil fuel burning were undoubted, but only when such people were both adaptable and knowledgeable. In almost all large scale installations these factors were given closest attention with resulting satisfactory operation.

In connection with the emission of heavy exhausts and fumes from street vehicles, it could be said that in the main the regulations under the Road Traffic Acts controlling construction and use of those vehicles were enforced in most areas by the police authorities, although it was an undoubted fact that in still weather conditions the concentration of gases and fumes from the moderate exhausts of Diesel vehicles, especially in built-up and busy thoroughfares, created a problem. The main cause of trouble in that field was due to fuel oil injector problems due to excessive wear and maladjustment, and under the regulations both of those causes were regarded as culpable offences. It would be true to say, however, that the frequency of such excess emissions was only a fraction of that experienced in the earlier and pioneer days of Diesel traction.

F. Taylor (Salford) offered his congratulations to the author on presenting a paper which bore the hall-mark of careful preparation. He felt that Mr. Sambrook had so thoroughly dealt with his subject that little scope remained for discussion.

Nobody with experience of oil-firing would deny its superiority over coal. Ease of control and adaptability to a fluctuating steam-load were two of its attributes. Cleanliness in transportation, storage and firing were others. Combustion efficiency of the highest order was attainable on a properly designed and maintained plant. The primary requirements were correct viscosity and effective atomization. Instrumentation was essential to efficiency whatever the fuel.

Sir Ernest Smith's reference to the need for supervision and interest in the boiler-house reminded Mr. Taylor that it must not be assumed that untrained labour could do full justice to oil-fuel. Trained operators were as necessary with oil as with coal, for when combustion was poor stack smoke was of the vilest type. The very simplicity of the method encouraged pitfalls.

Mr. Taylor stressed that oil fuel was particularly susceptible to price fluctuation and he could not forsee any appreciable replacement of coal by oil in industry until, having regard to its superiority, the price was more nearly related to that of coal. He recalled that in 1947 industrialists were invited to change over to oil. The target was a national consumption of 1 million tons per annum. One firm spent nearly £10,000 in equipping six Lancashire boilers and providing storage and the necessary heating only to be confronted with three price increases totalling 2½d. per gallon within eight months. The half-penny was the straw which broke the camel's back. The firm reverted to coal.

The present price of fuel oil, 185s. per ton, compared very unfavourable with coal at 80s. Mr. Taylor had found that even on a small plant, after making every conceivable allowance, the economic aspect could not be satisfied when the price of fuel oil exceeded 135s. per ton. Larger installations evaporating 30 to 50,000 lbs. per hour just could not afford

to burn it.

Councillor G. B. Jones (Huddersfield) referred to the high sulphur content of fuel oil. All the sulphuric fuel oil passed into the atmosphere, either as sulphur dioxide or sulphur trioxide, and little if any remained in the residue, whereas with solid fuel a proportion remained in the ashes. Even after allowing for the greater calorific value of fuel oil compared with coal it was clear that more sulphur was polluting the atmosphere from oil than coal for a given heat usage.

He suggested also that as combustion chamber temperatures were higher in oil furnaces than in coal furnaces more sulphur trioxide and thus sulphuric acid was given from burning oil than coal. He would like Mr. Sambrook's views on this point.

He pointed out that it should be easier to remove sulphur from oil than from coal or coke and hoped the oil producers would push on with research and development of processes for removing this sulphur. He had seen one plant at an oil refinery where the sulphur was recovered as elemental sulphur in a readily usable form. Recovery in this way would not only reduce pollution but add to our national resources of sulphur. Our only available sulphur was in coal, which could be recovered during gas or coke manufacture, and in an hydrite now being used for sulphuric acid manufacture, but involving a much higher capital cost compared with plant using pyrites or recovered sulphur.

We still had to import most of our sulphur requirements in the form of sulphur, pyrites or metallic sulphides and any sulphur recovered from imported crude oil would help our trade balance as the sulphur in the oil would cost nothing apart from recovery costs. He hoped Mr. Sambrook would touch on this point.

F. J. Redstone (Bristol) said he hoped that Mr. Sambrook would not feel disappointed because contributors to the discussion had been rather reluctant in coming forward. In his opinion, this was very largely due to the fact that many people were only on the fringe of this subject which it was hoped would receive a great deal more attention at future Conferences. Of course oil fuel could be the cause of nuisance and a great deal of trouble was experienced with it from time to time. He would like to refer to one aspect in particular.

Recently there had been a number of complaints throughout the country in connection with the low level emission of fumes from oil powered road vehicles and in Bristol increased attention was being given to this matter by the Medical Officer of Health.

The Public Transport Undertaking in Bristol was co-operating with a view to a reduction of this nuisance and the public had been asked, through the Press, to notify any particular instances, giving the time and place with registration number of vehicle, so that operation methods could be checked and adjustments made.

Mr. Sambrook, replying to the discussion, said that Sir Ernest Smith has rightly drawn attention to the desirability of proper training of boiler firemen and of the management taking a greater interest in the way fuel was being burned in their factories. The reason that management generally paid little attention to conditions in the boiler house was, of course, that fuel costs in so many industries formed such a small percentage of the total production costs that a correspondingly small amount of attention was devoted to fuel utilization. Regarding the training of the firemen, a good deal was already being done in that direction and training classes had been organized, but all boiler operators were not able to take advantage of those facilities. Mr. Ashford had also referred to the question of the training of operators and had suggested that greater skill was required from the firemen when burning oil than when burning solid fuel. Mr. Sambrook said that he did not think that was really so because the majority of firemen exercised a great deal of skill in handling solid fuel. Since we in this country were all of us used to burning solid fuel in one form or another, much of that skill was taken for granted. The amount of skill required to burn fuel oil correctly was not greater, but the technique was different. Much that a stoker had learned by experience in burning solid fuel, particularly the dependence of the rate of combustion on draught conditions, had to be discarded and new methods acquired when turning over to liquid fuel. As was mentioned in introducing the paper, the fact that fuel oil was generally burned without smoke was because it could be so easily and exactly regulated. On the other hand, fuel oil was not inherently smokeless as were such fuels as anthracite or coke and smoke could, therefore, be readily formed if the plant was not properly operated. One of the advantages of fuel oil was that it was

amenable to automatic control which could be applied so as to relieve the firemen of the responsibility of making the correct adjustments. Automatic combustion control was particularly suited to the smaller installations where, as Mr. Ashford had pointed out, trained operators were often not available.

Dealing with the question of exhaust from vehicle engines mentioned by many contributors to the discussion, Mr. Sambrook replied that that subject had not been included in the paper because it had been thought that it could best be dealt with in a separate paper by another author. As Dr. Parker had pointed out, the exhaust from Diesel engines was less harmful from the atmospheric pollution point of view than that from petrol engines, although that from the Diesel engine was in the form of visible smoke and thus attracted more attention when it occurred. That, however, was not a common occurrence these days and the large transport authorities maintained well-equipped workshops and inspection facilities to check their injection equipment. Regarding the exhaust from petrol engines, an undesirable concentration was only likely to arise where a number of vehicles were concentrated in a confined space with their engines idling. That atmospheric pollution problem was, therefore, bound up with the problem of traffic jams, but as no solution for the latter problem appeared to be in sight, it might well be that the technical problems would be solved first. The emission of products of incomplete combustion from petrol engines under idling conditions arose from the imperfections of the present method of distributing fuel to the engine cylinders by means of a carburettor. Other methods of fuel metering and supply were being actively investigated and although the object of those investigations was higher efficiency and fuel economy, they might also lead to a reduction in the emission of harmful exhaust products.

Mr. Sambrook said he was in entire agreement with Dr. Parker's plea for better instrumentation and better maintenance of existing instruments. There were still far too many boiler houses where if the stoker wished to see whether he was making smoke or not he had to leave the boiler house and walk to the far corner of the factory yard in order to be able to see the top of the chimney. That was simply not good enough. Reliable smoke indicators were now available and should be fitted in every boiler plant of any size. After all, one was bound by law to have on one's motor vehicle an instrument to ensure that one did not unknowingly exceed the 30 m.p.h. limit in a restricted area. It was not, therefore, unreasonable to ask that an instrument should be fitted in every sizeable boiler house as a measure to prevent danger to health by atmospheric pollution.

In reply to Mr. Taylor's remarks regarding the economics of oil firing, Mr. Sambrook said it was true that as a result of the severe coal shortage in the winter of 1946-47 some conversions to oil firing were made which could not normally be justified. The total amount of oil fuel used in this country was only about 3 per cent. of the coal used and the correct application of this comparatively small quantity of oil fuel was in those processes where it had special advantages and was able to replace a much larger quantity of solid fuel than was indicated purely on the ratio of calorific values. In general, the firing of large boiler plants was not an application which made the fullest use of the potential advantages of fuel oil. However, by employing oil firing for selected purposes, for example, the heating of hotels and large buildings in densely populated areas, fuel oil could make a much greater contribution to the reduction of atmospheric pollution than was represented by its small tonnage in relation to solid fuel.

In reply to Councillor Jones, Mr. Sambrook said he could assure him that the amount of sulphur dioxide converted to sulphur trioxide in the oil fired furnace was in fact very small, probably not more than 3 per cent. of the sulphur dioxide. Moreover, the proportion of sulphur dioxide converted into sulphur trioxide tended to decrease the higher the sulphur content of the fuel so that the amount of sulphur trioxide formed did not rise in proportion to the sulphur content of the fuel. In the case of solid fuel burning, the amount of sulphur which remained behind in the ash was only a very small proportion of that present in the fuel.

The possibility of recovering sulphur from petroleum had been very thoroughly investigated by the major oil companies, and sulphur recovery from refinery gases was successfully practised. It was no doubt sulphur recovered in this way which Councillor Jones had seen at an oil refinery. Unfortunately, however, no means had yet been discovered for removing the sulphur from fuel oils at

anything like an economic price.

The question of emission of fumes from road vehicles raised by Mr. Redstone had already been dealt with in replies to earlier speakers. It was interesting to hear that the Transport Undertaking in Bristol was enlisting the co-operation of the public in bringing to the attention of the Undertaking any instances of their vehicles transgressing in this respect.

RESOLUTIONS

After the Friday morning session of the Conference the following resolutions were proposed and were unanimously agreed.

1. The Women's Gas Federation urges the National Smoke Abatement Society to take special action in bringing the subject of smoke abatement to the notice of the women of the country, in particular by talks to women's organizations, articles in the women's Press (including the specialized journals of women's organizations) and feature items in women's sound and television broadcast programmes.
2. That we, as a Conference, view with alarm the menace of fumes caused by the extension of the use of Diesel oil engines and faulty maintenance of these, and that all Local Authorities and Police be requested to enforce and if necessary increase their powers to ensure minimizing or suppression of these fumes in the interests of public health.

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NATIONAL SMOKE ABATEMENT SOCIETY
Annual Conference, 1953, City Chambers, Glasgow

Presidential Address

SMOKE AND THE LOCAL AUTHORITY

by

Alderman Professor Frank E. Tylecote, M.D., D.P.H., F.R.C.P.Lond., J.P.

Early History—Manchester as an Example

Some months ago your Secretary suggested to me that this address should deal with "Smoke and the Local Authority." I then began to look into the early history of the concern of Local Authorities for smoke matters. I did not find this too easy and I must ask you to pardon me if my early references are somewhat weighted in the direction of Manchester and Salford, as being easier to come by. In Manchester then we have to begin with a study of the doings of the manorial court or "Court Leet." In the 16th century their powers extended over the whole of the life of the town; by 1834, when Manchester passed its first bye-law (re industrial smoke) these powers had become limited to short weights, smoky chimneys, and offensive smells. In 1801 we note that a Nuisance Committee which had been appointed reported at the end of their report that —"the increase of steam engines as well as the smoke issuing from chimneys used over stoves, foundries, dressers, dyehouses and bakehouses, have become a great nuisance to the town unless so constructed as to burn the 'smoak' arising from them, which might be done at a moderate expense." In 1838 the report of the Scavenging Committee concluded "by these means it is hoped that as far as the peculiar soil of the district, the quantity of soot falling and the great traffic on the streets will admit, no just reason will remain for complaints on this subject." I find that the Nuisance Committee appointed by the Police Commissioners about 1840 had to appoint inspectors and suppress nuisances and to carry out police regulations "relating to the height of chimneys, for the purpose of preventing nuisances arising from smoke and . . . . to take any steps which may be necessary for compelling the owners and occupiers of steam engines and fire engines to construct the fireplaces and chimneys thereof respectively in such a manner as most effectually to consume and destroy the smoke arising therefrom."

In 1844 the Nuisance Committee of the Borough Council, which had from a year previously acted for the township of Manchester, now gave place to a nuisance committee for the whole borough. This committee received special instructions about the suppression of the smoke nuisance and was directed to enforce Section 75 of the

Borough Police Act against all parties throughout the borough " who after due notice shall not so far as is practicable consume the smoke arising from their own furnaces." It is interesting to note that the Court Leet still functioned to some extent and in 1844 still fined or " amerced " factory-owners who allowed large quantities of smoke and soot to issue from their factory chimneys. In 1846 the Chief Constable reported " that it was common knowledge that the town was much freer from smoke than formerly" and in 1847 the Nuisance Committee appointed a special inspector for the suppression of the smoke nuisance. In 1865 Samuel Hurst was appointed Smoke Nuisance Inspector at 27s. per week. In 1850 it was reported that the smoke inspector had in the previous year taken observations of 510 chimneys, served 67 firms with notices to improve their furnaces, and had cautioned the owners of 231 other mills; 19 had been summoned, of these 16 had been fined the other three being withdrawn on its being shown that alterations were actually in progress to lessen the smoke. The first Manchester Smoke Inspector appointed under the smoke abatement powers in the Manchester Police Act of 1844 must have had an exciting time. He found one cotton mill emitting smoke for 8 hours 52 minutes out of a nine hours observation. Others varied from 8 hours 2 minutes to 1 hour 50 minutes.

Still the smoke nuisance persisted and increased. In 1854 Dr. J. P. Kay reported for the Manchester Board of Health that the district known as " Little Ireland " was surrounded by some of the largest factories of the town " whose chimneys vomit forth dense clouds of smoke which hang heavily over this insalubrious region." In 1844 and 1845 Peel's Tory Government's Royal Commission reported that the provisions regarding smoke abatement found in certain local acts were to be generalized. About this time a body called the Towns Improvement Company issued a report later confirmed by Dr. Lyon Playfair in which *inter alia* Manchester was complimented for its anti-smoke proceedings " against powerful manufacturers " and here Dr. Playfair put Manchester first " as it had hitherto done its duty so well."

In 1868 Dr. John Leigh was appointed Manchester's first Medical Officer of Health, and soon the work of co-ordinating the committees was begun, and the Nuisance Committee, which had previously had the dealing with smoke problems as one of its duties became merged in the new Health Committee.

In 1850 Archibald Prentice had written " the volumes of smoke which continually issue from factory chimneys and form a complete cloud over Manchester certainly make it less desirable as a place of residence than it is as a place of business; and the enjoyment of the inhabitants would be greatly increased could they breathe a purer atmosphere, and have a brighter and more frequent sight of the sun."

In 1854 the eminent Town Clerk of Manchester, Sir Joseph Heron (Town Clerk 1838-87) reported to the General Board of Health that " dense smoke is hardly ever seen, and smoke of any description is very rarely and for very short periods observable." The Board replied, as one might have expected, " we regret to learn that Manchester with all the improvements effected is still a very smoky place." Mrs. Gaskell, however, found " green fields and meadows " in her walks in the Greenheys district of Manchester—difficult to imagine today!

So much for the Manchester of those days; now let us look how things were faring elsewhere.

Salford had four part-time policemen doing the smoke inspection work in 1844; and one full-timer from 1854. Leeds had an inspector in 1905. It was left to the London Coal Smoke Abatement Society to appoint the first smoke inspector for the metropolis and his name was Petty; it will

live as long as our Jimmie Law's predecessor at Sheffield—Nicholson, or as that of Alderman Adams at Newcastle. Birmingham had four smoke inspectors in 1903, whole or part-time.

Edinburgh

Interest in smoke abatement in Edinburgh does not appear to have begun until our member Allan W. Ritchie was appointed Chief Sanitary Inspector but at his instigation the local authority has got active in many ways—they have for instance a women's association and the age-old appellation of " Auld Reekie " is losing force.

Glasgow

Even if we were not in Glasgow there could be no hesitation in naming that redoubtable Glaswegian, Bailie William Brownhill Smith, who gave as his reason for joining the City Council " a desire to secure some effective control over the pollution of the city's air." He used to lecture on smoke abatement, using lantern slides of his own manufacture and he, in his enthusiasm, journeyed as far as Pittsburgh, U.S.A., to give lectures on the subject. This was in 1913; in 1920 he was a member of the Newton Committee on Smoke and Noxious Vapours Abatement, and he continued to do active work for smoke abatement until his final retirement in 1939. He was one of the founder members of the Scottish Division of the Society, then known as the Smoke Abatement League of Great Britain, and he was for many years acting vice-president —the Lord Provost for the time being acting as Hon. President. This is a most notable example of a voluntary worker pioneer finding he could do better work by joining the local authority and working from within. He died in 1948, aged 85.

In considering the early smoke history of both Glasgow and Manchester, we find references which suggest that smoke troubles in both these cases only began in the last century. McUre in 1736 found Glasgow " surrounded by cornfields, kitchen and flower gardens, and beautiful orchards, abounding with fruit of all kinds, which by reason of the open and large streets send forth a pleasant and odoriferous smell " while Eyre Todd's history states " at the end of the 18th century the clear atmosphere began to be darkened with a coud of smoke."

Glasgow has for over 35 years been noted for its stokers' classes. They have both elementary and advanced, and if a man after being certified holds down a job for over two years, he is entitled to a block grant of £25. Glasgow has through one of its most munificent benefactors shown us what atmospheric pollution is losing us from the aesthetic point of view for Sir William Burrell desiring first to donate to this city a valuable collection of paintings, etc., felt himself compelled to make it a condition of the bequest that they should not be shown within ten miles of Glasgow and later left a quarter of a million sterling towards building a gallery as a home for the bequest, " not less than thirteen miles from Glasgow Royal Exchange."

Before I leave Glasgow or Scotland I must remind you that the term " black smoke " which, except in Nottingham and Leeds, is essential in the proof of a prosecution in England under section 104 of the Public Health Act, 1936 (but not under s. 101, where a nuisance must be proved), is unknown in Scotland's smoke byelaws. Here the adjective used is " dense " and two minutes of dense smoke in 60 will suffice to make a prosecution proven.

As I am speaking in Glasgow a word or two about the friendly rivalry between the two sister cities may not be out of place. I understand that Edinburgh concedes precedence to Glasgow so far as smoke production is concerned and the gauge records would seem to confirm this. But in my part of the world we have a saying, " Where there's muck there's money," or, as you here probably say, " brass," so here may be a cause for

rivalry! And the muck in the atmosphere, though the said money got from it, accrues to the benefit both of those whom the U.S. call morticians and the profession to which I belong. But Auld Reekie—the name must have arisen in ages past when Glasgow was green fields and long before industrialization. Their smoke must have been domestic. I seem to have read somewhere in Scott or elsewhere " Reekie's put her caps and bonnets on " of an occasion when, in those days, a prosecution for black—I beg Scots law and pardon, I mean dense—smoke would ensue. I am on more ticklish ground if I refer to another saying often quoted between two other rivals, " Manchester men and Liverpool Gentlemen," because I have also heard of saying that when a visitor arrives in Glasgow, Father says " Put on the kettle Mother " while in Edinburgh he says " Turn on the wireless Jean." One last point to allay any possible fears: There is an expression peat-reek which refers to smoke from burning peat presumably used in a distillery, but also I believe, a synonym for the product of the distillery. I hereby declare that it is no part of the policy of this Society to wage war on or seek abolition of that commodity.

Smokeless Zones

Smokeless Zones, which we owe to the inspiration of our late Chairman, Charles Gandy, a Manchester barrister, are more suited for local control than are most features of Smoke Abatement propaganda. The demand for a smokeless zone must, it seems to me, indicate a local authority awareness of the serious impact of the excessive smoke on the health of its citizens. Two reasons were given for a recent refusal to allow a smokeless zone scheme to proceed—(i) shortage of suitable smokeless fuels and (ii) shortage of steel for conversion of appliances. As regards (i) the locals knew better and as regards (ii) the ban on the use of steel for making appliances has now been removed. Manchester and Coventry smokeless zones have now been in being for roughly a year and a half each. Manchester got its powers first, but Coventry got into action first and we shall hear from Dr. Clayton, Coventry's medical officer, tomorrow morning, some account of their first year's working.

Sheffield has always been in the forefront of Smoke Abatement measures. Its school for stokers has had a two years' course for many years at the end of which the candidates take the City and Guilds certificate. Those holding this thereby obtain preference in getting posts, but increase in pay should be the reward. Proficiency should be periodically tested, as in the St. John Ambulance Teams—especially the railway teams.

Statutory and Advisory Committees

But the thing which makes Sheffield unique in Smoke Abatement work is that it is the seat of the Sheffield, Rotherham and District Statutory Committee. These two Corporations jointly agreed to pool smoke duties from 1st July, 1927, and later, from 1st April, 1930, an agreement was made which included at first, four and now five district councils. The first four were Rotherham Rural, Stocksbridge Urban, Rawmarsh Urban and Greasborough Urban. All the members of this body are members of local authorities or officers thereof. The Inspector of this Statutory body has four assistants and he can enter all areas which have joined but cannot go into areas which have stood out from the scheme and which are getting benefits they do not pay for as smoke has no boundaries. A grid system is really needed. This is the first Statutory Committee to be set up under the 1926 Act, and so far the only one, though had it not been for the last war several regional committees would no doubt have become statutory committees before now. Domestic chimneys are not included in this scheme, the expenses of which are met by the constituent authorities according to their respective rateable values.

The Manchester and District Regional Smoke Abatement Com-

mittee now has upwards of 80 subscribing local authorities. If statutory committees such as the Sheffield and Rotherham one, the pioneer, were made compulsory we might get somewhere. Either increase the work of the Alkali inspectorate to include smoke and all factory chimneys, as suggested in 1898 in the Leeds Smoke Abatement Society's unsuccessful memorial to the Local Government Board, or introduce a " grid " system. Don't allow any local authority to " stand out." " Gaps " mean failure. To stand out is nothing but pure selfishness and narrow-mindedness. Full consultation with the Ministry of Fuel and Power and its officials and technical staff is essential.

Apart from Sheffield, in Yorkshire, Bradford, Leeds and Huddersfield had early stokers' classes and did pioneer work in this way. The local acts often differ in their provision, e.g., the Leeds local act does not restrict prosecutions to *black* smoke, and it provided for the appointment of a smoke inspector, who was appointed in 1905; Nottingham (1874) preceded Leeds in not being limited to black smoke, and this act does not admit the defence that " the best practicable means " have been used. Some acts imposed higher penalties than the National Public Health Act of 1936: these were Nottingham, Leeds and Sheffield. Bradford dealt with grit also (1913, 1916). Birmingham had four inspectors in 1903 (whole or part time). They made their first byelaw in 1927 under the 1926 Act, which was superseded by a later one in 1937. The Midlands Joint Advisory Council was formed in 1928, also under the 1926 Act; this is a voluntary body whose membership derives solely from local authorities and in 1939 it enlarged its scope so that it covered fumes, dust, etc., connected with industry and not necessarily with heating installations only. The West Riding, London and the Home Counties and Teeside also have advisory committees.

The principle of " prior approval " already in force for chemical and other works under the Alkali Act was extended to combustion processes by two local acts of 1946—the City of London (Various Powers) Act and the Manchester Corporation Act. This spread of prior approval clauses may truly be said to be largely due to the work of the N.S.A.S.

In considering the future relationship of the Local Authority to the Government regarding Smoke Abatement we are compelled to argue from past experience and remember that the lead has always come from the local authorities and never from Whitehall, who have consistently refused local authorities' requests. It is beginning to look as if this was going to be the position regarding smokeless zones because the reasons given for refusal a year or two ago have not applied for many months past.

The position regarding smoke inspectors is difficult. The smaller local authorities have not the power or the money to do the job effectively. They, certainly, could not pay a sufficiently well-qualified inspector, who, in the future, must be an engineer. But, as the law stands today, they can refuse to join a regional advisory committee, or, by standing out, a statutory regional committee such as Sheffield and Rotherham, and so refuse the Inspector access to their territory. It is also clear that while certain larger authorities are really efficient in their drive against smoke, yet others both large and small, do not take their duty seriously. Some are influenced by the false argument that " *we* have no smoke," forgetting that smoke knows no bounds and that other people's smoke invades them whether they know it or not, and may do so more in the future; others are in the power of large local industrial leaders who are antagonistic, either with the idea of keeping the rates down, or, some of them, strange as it may seem, still imbued with the idea that " we want *more* smoke," on the theory that more smoke means full employment at the factories. So far, and going back very many years now, the Government has practically always

refused the suggestions of local authorities or has taken " no action," save the appointment of committees who take years to report.

Propaganda

In going through the records of local authorities in relation to smoke one is struck by the turn which their anti-smoke activities have again and again taken in the direction of organizing meetings, and of course, less frequently, exhibitions, and how these, especially the exhibitions, have been followed by a definite increase in local anti-smoke activity. The great Mansion House meeting organized by the Lord Mayor of London in 1883 had followed the South Kensington Exhibition of 1881, which 116,000 people attended, and the Manchester Exhibition of 1882. In all smoke abatement work the Public Control Committee of the London County Council has always played its full part. Their 1904 report, which incudes a history of the problem, especially as regards London has been most valuable. They have recently become members of the N.S.A.S. At all exhibitions the attendances have been uniformly good, the press have been invariably helpful and in the case of Manchester a subscription list of £800 was put up before it opened, to defray expenses, which included the publication of a daily journal. This exhibition was opened by the Mayor, and owed much to the enthusiasm of Principal J. W. Graham and of Mr. T. C. Horsfall. Sheffield held an exhibition in 1909 and in 1912 an international smoke abatement exhibition was held at Islington. At this period neither women nor juveniles were apparently especially interested, and in the future I have great hopes of both these groups.

The Potteries—Replacement of Bottle by Tunnel Kilns

Smoke Abatement in the Potteries is making great progress as a result of the gradual conversion of the old intermittently fired bottle kiln to the continuously fired gas or electric tunnel kiln which has been going on for some years now. In 1940 there were 2,191 bottle kilns still in use; in 1948 there were 1,403; in 1953 there are about 1,000. The consumption of gas for pottery firing was 7,444,000 cubic feet in 1932; in 1952 it was 4,778,889,200. The number of gas-fired kilns in 1932 was one; in 1952 it was at least 209. As regards electrically fired kilns the units of electricity used for ceramic firing was 4.2 million in 1932; last year it was 62 million. In the year ended 1st April, 1938, 21 kilns were electrically fired; in 1948, 58; in the year ended 1st April, 1953, there were 131, i.e., 111 continuous and 20 intermittent. It is calculated that three coal-fired bottle kilns can be replaced by one continuous electric kiln. The most recent figure for the cost of electricity for firing purposes is 0.931d. per unit. As early as October, 1940, Wedgwoods were using their electrically-fired tunnel kiln at their new factory at Barlaston. (See article in *Smokeless Air*, Spring, 1941). It has been calculated that there has been a fourfold increase in gas-fired kilns since the war, and that the amount of coal saved is two-thirds. Another calculation is that of the 1,000,000 tons of coal used in the potteries pre-war, only 400,000 tons or two-fifths are now needed. While the fuel costs go down so does the amount of speckled rejects, *and* there is no smoke emitted. But the full advantages of tunnel firing can only be achieved if the conversion takes place as part of a complete modernization of the works, requiring considerable capital and only possible of fulfilment when trade is slack. But saving includes, apart from fuel costs, the cost of labour in placing, of saggars and of kiln furniture; whilst dumps of coal fuel and of ashes, with consequent labour, are no longer seen and general working conditions are much improved. One looks forward, at no very distant date, to the last bottle kiln being " plaqued " and scheduled as an Ancient Monument.

But the smoke nuisance in the Potteries is still serious. There are still notable omissions from the new

method of firing and the problem of domestic chimney smoke is still there. At two of the three recording stations the total solids deposited have been reduced by about one-eighth, whilst the third station shows no improvement up to the date when, owing to the outbreak of war, the readings ceased. It may perhaps be assumed that the same lessening has occurred there. The recent yearly average readings of the one lead peroxide instrument (Leek Road, Stoke), show a reduction in sulphur dioxide as compared with pre-war years, expressed as m.g. SO_2 per day per 100 sq. cms. exposed surface (cowl covered instruments),

e.g., 1935-6—2.71
1951-2—1.70

Appeal to the fortunate ones

I now, before closing, wish to make a definite appeal to the more fortunate ones. I have twice before in this address indicated by statement or by inference that in certain quarters there is a lack of team spirit or " esprit de corps " and I wish to emphasize this aspect of things. We know that " smoke knows no boundaries " and those of us who have visited the Isle of Man know that a good example of that slogan is to be found there, when in certain winds, the smoke from the industrial mainland reaches as far as that island. The local authorities in the more fortunate areas should surely become interested, join the Society, not remain outside of the regional committees, etc., for—to put it no higher—they will thereby be safeguarding their own future, as industrial areas change localities, they will be recognizing the truth that many of the smoke burdens are truly national and that some of them they are even now bearing unwittingly. Even County Councils which tend to remain aloof should be interested, for though not smoke abatement authorities under the Public Health Act they are directly concerned with the general health and with housing and town planning. The Ministry of Housing and Local Government has now indicated that they may apply for membership with the Ministry's approval.

Methods by which Local Authorities may Advance Anti-Smoke Propaganda

1. The institution of more regional committees, and the making statutory those already existing.

2. The formation of women's associations on a par with the Electrical Association for Women and the Women's Gas Federation, which have done and are doing such good work.

2A. A similar, but juvenile, organization.

3. The creation of more smokeless zones and the extension of those already existing.

4. By repeated approaches to Government departments regarding (3).

5. By increasing the number of smoke inspectors and improving their qualifications.

6. By forming more " stokers' schools " as so well and long run at Glasgow, Manchester and elsewhere.

7. By exhibitions, meetings and broadcasts.

8. By appealing to local authorities not directly and immediately concerned to play their part as a safeguard against the future—and to note that their air is no doubt polluted from elsewhere by wind-driven sulphur fumes, etc.

9. Through the Central Council for Health Education.

Financial Aid of Local Authorities to Smoke Abatement

This must be worked out under various heads, such as:

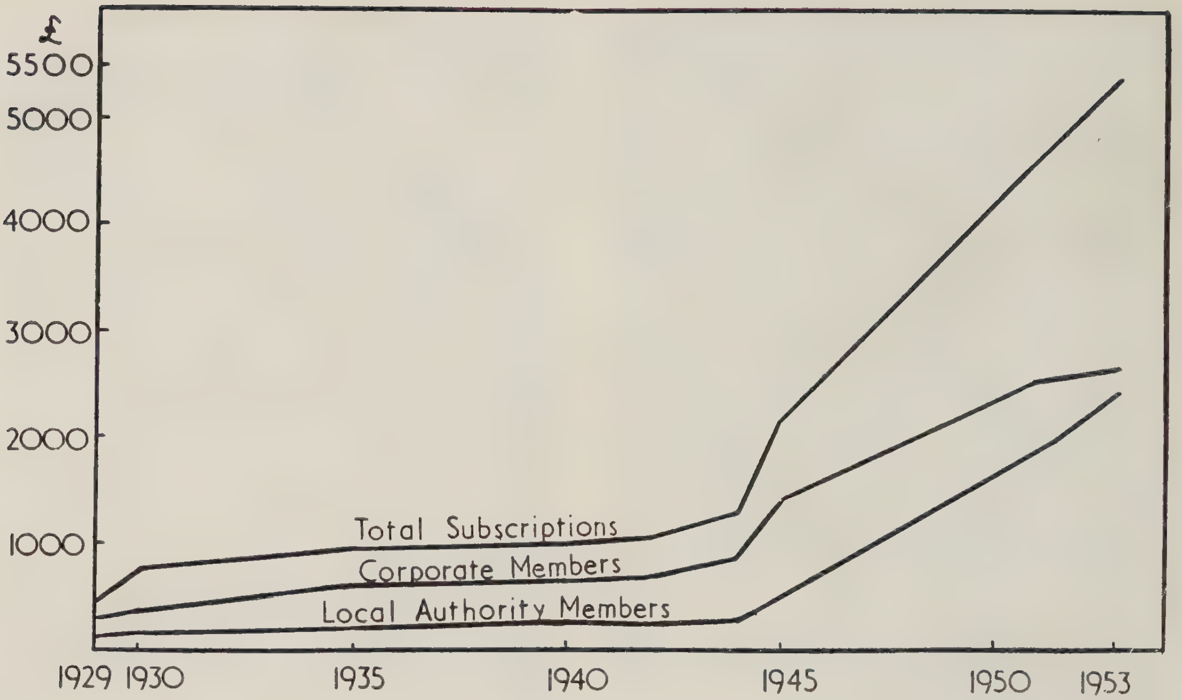
1. Cost of inspectors, etc., regional committees, expenses to N.S.A.S. meetings and conferences and those of the Standing Conference on Atmospheric Pollution.

2. Local propaganda, exhibitions, etc.

3. Cost of Acts, byelaws, powers for smokeless zones, etc.

4. Subscriptions to the National Smoke Abatement Society.

Some of these headings it is almost impossible to estimate the cost of, but the following figures show how subscriptions from local authorities to the



The Society's Annual Income (*Individual Membership Subscriptions not shown*)

National Smoke Abatement Society have increased fourteen times since 1930:

Year ended 30th June, 1930—£175
" " 1940—£269
" " 1951—£1,832
" " 1953—£2,444

In 1930 the average local authority subscription was £2 13s.; now it is £6.

Over the same period of years the subscriptions of individual members, apart from the war years, have increased slightly, whilst those of corporate members rose even more strikingly than those of local authorities. Here are the figures:

Year ended 30th June, 1930—£363
" " 1940—£610
" " 1951—£2,515
" " 1953—£2,649

The Society has now more than 440 local authority members; in 1929, at the time of the first conference at Buxton, when the two older bodies amalgamated, it had 66. The curve formed by the local authority and corporate member groups is shown in the accompanying chart. It is also interesting to note that our first Glasgow conference in 1934 broke the then record for attendance—195. The score today is more than double that—about 450

Epilogue

Now I have come to the end of my active duties as President. It is a great pleasure to thank Mr. Marsh and Mr. Silver and the rest of the Staff—now one more in number than a year ago, as a result of increased subscriptions—for all the help they have given me throughout my term of office. I also owe my thanks to Sir Ernest Smith, my successor, to whom I add my best wishes, and to Mr. Duguid, and in connection with this address to Dr. Stuart Laidlaw and Mrs. Laidlaw and Mr. Ashford, of this city; Mr. Hurst and the Gas and Electricity Board Managers at Stoke-on-Trent; Messrs. H. Moore and J. Lawson, and to Doctors Martine, Metcalfe Brown and J. L. Burn; also to Alderman Yorke and Dr. Llewelyn Roberts of Sheffield.

I have enjoyed my period of office. It is always both pleasurable and profitable to work with a keen team, who work as a team.

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NATIONAL

SMOKE ABATEMENT SOCIETY

FUMUS FUGETUR

Proceedings

of the

Scarborough Conference

1954

Price 7/6d.

30 GROSVENOR PLACE
LONDON, S.W.1.

The Society's Publications

This is one of the many publications of the National Smoke Abatement Society. For a complete list write to the Society for its current Year Book. This contains a Guide to Publications on Smoke Prevention and Allied Subjects, which lists, in addition to the Society's own titles, particulars of other books, reports and papers, including Government reports, any of which may be purchased from the Society. The list is classified according to subject—the Law, Conference Proceedings, General, Historical, Smoke Prevention Administration, Industrial Smoke, Domestic Heating, Technical and Scientific, and Industrial Pollution.

NATIONAL SMOKE ABATEMENT SOCIETY

Proceedings of the 21st Annual Conference Scarborough

22nd to 24th September, 1954

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30 Grosvenor Place, London, S.W.1.

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Scarborough Conference

SUMMARY OF EVENTS

The delegates were welcomed, and the Conference officially opened by the Worshipful the Mayor of Scarborough, Councillor Miles Bird, J.P., on the morning of Wednesday, 22nd September, 1954. Sir Ernest Smith's first Presidential Address followed.

On the afternoon of the same day Sir Hugh Beaver, Chairman of the Committee on Air Pollution, addressed the Conference, Dr. W. R. Martine, Chairman of the Executive Council, being in the Chair, owing to the President's indisposition. The Chairman opened discussion on the Address, and was followed by Dame Vera Laughton Mathews and Dr. Charles White. General discussion then took place.

On Thursday morning, 23rd September, with Mr. James Goodfellow in the Chair, a paper was read by Mr. R. F. Harvey on developments promoting smokelessness in railway locomotion. In the afternoon the subject was "Developments in the Industrial Uses of Gas and Electricity." Two papers were read, one by Mr. R. F. Hayman of the Gas Council, and the other by Mr. J. I. Bernard of the Electrical Development Association. The Chairman was Dr. W. A. Macfarlane, Director of the National Industrial Fuel Efficiency Service, who made an informative contribution on the nature and work of his organization. The papers were followed by general discussion.

After the morning session the new Gas Council film "Guilty Chimneys" was shown, preceded by the new C.C.H.E. film strip "Fog is Officially Forecast."

On Thursday evening members of the Conference were invited to a Civic Reception, at which the Deputy Mayor and Mayoress of Scarborough (Alderman and Mrs. Storry) were the hosts.

On Friday morning Sir Edward Salisbury, Director of the Royal Botanic Gardens, Kew, delivered the Des Voeux Lecture, on Air Pollution and Plant Life, with Dr. Martine in the Chair.

The Conference concluded with the Annual General Meeting, with Dr. W. R. Martine as Chairman.

At the end of the proceedings a vote of thanks was moved by Mr. J. J Matthews to the authors of papers and the sessional Chairmen, to the Mayor and Mayoress, and the Deputy Mayor and Mayoress, to Mr. S. H. Fewster, Scarborough Conference Officer, the management and staff of the Olympia Hall, and the Society's staff.

The following resolution, moved by Alderman J. Chapman (Newcastle-upon-Tyne) on behalf of the Executive Council, was considered by the Conference and carried unanimously:

> "That this Conference of the National Smoke Abatement Society calls upon the Minister of Housing and Local Government and Secretary of State for Scotland to promote early legislation granting permissive powers to local authorities to establish smokeless zones, thereby obviating the necessity for the promotion of Private Bills."

Presidential Address

THE COAL CRISIS—AND THE SOCIETY

by

Sir Ernest Smith, C.B.E., D.Sc., F.R.I.C., M.I.Gas E., F.Inst.F.

Fellow Members—

I appreciate very much that you have thought fit to elect me your president. I have been a member since the Society was formed with its primary object of bringing home to the community the evils of smoke—and atmospheric pollution generally. Its chief function is education and propaganda for the proper use of coal, whether domestic or industrial. In those days coal was cheap and little thought was given to its efficient use. Domestically the *only* concern was comfort—and I am afraid still is—industrially the main concerns were the quantities of steam raised at the required pressures, and a high output of manufactured products without reference to the amount of coal used. Today I think it is fully recognized that thermal efficiency and the reduction of smoke go hand in hand and, especially in industry, better products are made with a material reduction of " spoils ".

Domestically there has not been the advance that one could have wished. Even today the greater proportion of the heat of the coal fire goes up the chimney, inducing from five to six times the amount of air required for adequate ventilation of the rooms and causing unnecessary draughts from doors and windows, with consequent discomfort and the inevitable tendency to use more coal to neutralize the discomfort caused by the cold air admission.

Today the world is in a ferment and many revolutions are in progress—old ideas, old skills and techniques, old ways of life are giving place to new.

New forces and new machines are at our command. These may lead to catastrophe or to a better civilization. One of the revolutions is the way in which we obtain and use the energy which to an ever increasing extent we need in the form of heat, and motive power. This affects our own country more sharply than any other—first because as a highly developed industrial nation we need so much and will need more (and need it as cheaply as possible)—and secondly because the sources from which we can draw it are so precious.

With our present knowledge only a small fraction of the energy we need can be looked for from the newer methods that are being developed or discussed—water power, the winds, the tides, the sun itself, or from crops grown for the production of fuel alcohol. The heat pump has its possibilities but they may take a long time to mature and like others may call for considerable capital expenditure. The use of nuclear energy for peaceful purposes is of course coming, and may come fast, but even here there are limitations. It may replace coal in our power stations, but we shall still need power stations, vaster and more costly than ever, and we shall still have all the costs and problems of transmission and distribution, and the difficulty of the peak load. It will come, but it will only be gradual and it may not meet all our needs.

For the immediate future we have

no choice but to continue to rely mainly on coal, despite the fact that it is a wasting asset, is bound to become scarcer and more difficult to mine and to become less satisfactory in quality. Our coal measures took millions of years to accumulate, and we have used them up with an unthinking prodigality that will shock future generations. At last we are realizing this, and are at the beginning of another revolution—one that seeks to use coal as carefully and as sparingly as we can. We are like travellers in a desert with water bottles almost empty and a long way from the next oasis.

This energy revolution is entering our homes, where it is allied to other revolutionary changes and trends with which we seek greater comfort and cleanliness.

And so we come to the revolution which this Society exists to bring about—a revolution of ideas, directed against the toleration of the appallingly polluted air from which this country has suffered for so many generations and which has caused immeasureable ill-health, wasted millions of tons of coal and cost us vast sums of money. Compared with some of the other changes we see in progress, or struggling to make progress, and which are changing the course of history, this problem of air pollution may seem only a small domestic issue, but we must not overlook that it is closely linked with our new ideas about fuel and energy, the new ideas about our homes, the new ideas about efficiency in industry, and the growing understanding of the importance of Conservation as opposed to Waste.

Some Achievements

Already great advances have been made which should not be ignored—as they point the way for much further development in other directions. I will mention only three industries—major ones—of which we as a nation can be proud.

(1) *The Electricity Industry*

In 1925 the efficiency of coal utilization for the whole industry was less than 13 per cent but rose to over 22 per cent in 1952, the most efficient station being just over 29 per cent.

The fuel saved in 1952 by the improvement in efficiency over 1925 amounts to over 27 million tons. If all stations had been equal to the best in 1952 a further 8.0 million tons would have been saved. It seems anomolous that today the fuel consumption is only 35.3 million tons. This of course is because of the enormous expansion of the industry.

(2) *The Gas Industry*

This industry also shows a considerable advance. It was well established long before the introduction of public electricity and is fundamentally an industry using coal efficiently. However today it consumes 28.5 million tons of coal. The coal saved in 1952 compared with 1925 was 3.2 million tons, and if the whole industry were as efficient as the best station there would have been saved 4.0 million tons. There is such a close relationship between these two figures that it indicates that most of the large stations closely approximate to the best and that the worst are very small indeed.

(3) *The Steel Industry*

Figures comparable with the above are not easy to deduce but I have been fortunate in obtaining from knowledgeable sources figures that are *approximately* indicative of facts.

It is known that the main use of fuel in the steel industry is in the blast furnace. It is estimated that the amount of coke used there per ton of pig iron has been reduced from just over 26 cwts. per ton of iron in 1920 to 24 cwts. in 1929 ; 22 cwts. in 1937 and about 20½ cwts. in 1953.

The estimate of the amount of coal used per ton of *finished steel* produced has been reduced from 63 cwts. in 1920 to 51 in 1929, 41 in 1937 and 38 in 1953.

The total coal equivalent used in the steel industry in 1922 was 26.9

million tons. If the efficiency of fuel use had been that of 1925 the fuel consumption would have been 43.7 million tons, so that the saving in coal for the same output would be approximately 16.8 million tons.

From the above three sets of figures there has been a saving of about 47 million tons on 1952-3 output when comparing the 1925 figures with those of 1952-3. This is most encouraging, but it is not the limit of what can be attained. The total consumption of coal equivalent in the three industries in 1952 was about 90 million tons or over 40 per cent of the national coal production. What can the other users of the remaining 60 per cent of our coal consumption do ?

I am satisfied that there can be eventually obtained equally good results in the rest of industry. In the main it only requires training, knowledge, and keeness in all users of fuel from the managers to the individual workmen to bring this about.

But, you may ask, what has this to do with Smoke Abatement and the elimination of atmospheric pollution ? The answer is that smoke is a sure sign that coal and oil are being wasted and that the surest means of reducing the smoke nuisance is to use coal and oil with the maximum practicable efficiency. There is no need to labour this point.

Research

Very definitely the problem of atmospheric pollution is being comprehensively tackled and whilst it is undoubtedly important to know in precise detail the extent to which health, agriculture, buildings and our national economy are being adversely affected, it should not be necessary to wait for absolute proof from statistics before tackling all the problems of atmospheric pollution in a comprehensive way. No one will deny that the fresh atmosphere of the open country and especially the sea is preferred to the congested atmospheric condition of the city. The nearer one can attain the former the better it is for all those condemned to spend most of their lives in the latter, and we must convince the public as a whole that it is to their advantage individually that each should pull his weight in all possible and practicable ways to improve the present situation. The 1952 'Smog' experience brought this home to us but for many years London has been noted for its winter pea-soup fogs. Certainly these have latterly been less frequent but with the increase of motor traffic and the introduction on an increasing scale of the use of diesel motor traffic I am afraid, unless radical steps are taken, atmospheric pollution will become more serious ; and if during our coming winter the meteorological conditions are similar to those of December 1952, the Smog crisis will continue to be with us. The problem is being studied in many directions. Under the leadership of the Fuel Research Board there is of course the Atmospheric Pollution Research Committee—although with limited resources of trained personnel and finance—doing invaluable work on the measurement and effects of atmospheric pollution and on its abatement. Under its guidance are continued the systematic measurements of air pollution which were started in 1912 under the guidance of an Advisory Committee and taken over a few years later by the Meteorological Office. In 1927 the work of this Committee was transferred to the Department of Scientific and Industrial Research.

In order to bring about a closer association between work on the measurement of pollution and work which aimed at its abatement, the Atmospheric Pollution Committee was in 1945 reconstituted as a Committee of the Fuel Research Board of the Department of Scientific and Industrial Research and the work considerably extended.

The measurements of atmospheric pollution carried out by the local authorities and other co-operating bodies are assisted and co-ordinated by the Board. The rapid growth of the scheme in recent years is shown by the following table :—

Year ended 31st March	Numbers of Co-operating Bodies making measurements	Instruments in regular use
1945	41	189
1948	54	333
1951	110	890
1954	192	1402

Results of tests are now received by the Fuel Research Station at the rate of about 130,000 per annum and a monthly bulletin is distributed to the co-operating bodies with references to current literature on the subject. About 700 are distributed monthly and a conference is called regularly of the co-operating bodies to review the facts. The Department has given me permission to report that—

> " Latterly arrangements have been made to obtain information on the effects of exhaust gases from diesel, and petrol engines of road vehicles on the pollution of the air in busy streets by carbon monoxide, sulphur dioxide, smoke, various hydrocarbons, etc., under various meteorological conditions—including times of fog."
>
> " *Smog investigations.* During the severe fog that covered London for a week in December, 1952, there were 12 daily instruments for measuring smoke and sulphur dioxide in operation in that area, in addition to more than 100 monthly instruments; these gave more detailed information on the prevailing pollution than had been obtained during any previous incident of this kind including those which occurred some years ago in Belgium and the U.S.A. One important observation was that at no test-site did the average daily sulphur dioxide concentrations approach the generally recognised toxic limit for that gas. Thus, although the possible effects of sulphur dioxide on the smog victims cannot be discounted, the emphasis has been given to other lines of toxicological study.
>
> " By the use of both daily and monthly readings it was possible to deduce an approximate mean distribution of pollution in the London area for the smog period. By arrangement with the medical authorities the statistics on the deaths in the area have been examined in great detail for comparison with the distribution of pollution in the area at the time.
>
> " During the winter of 1953/54 the Fuel Research Station prepared to collaborate in trials which aimed at the large-scale dissipation of fog or smog by spraying it with very dilute solutions of chemical with certain surface-active properties. All the necessary equipment was assembled at a suitable site but no dense fogs occurred. The investigation has now been switched to work with artificial fogs but will be applied to natural fogs when a suitable occasion occurs.
>
> " Arrangements are being made to secure, in co-operation with local authorities in the London area, more frequent and extensive measurements of smoke and sulphur dioxide during any severe smog which may develop during the coming winter. A suggested schedule of measurements, with the approximate locations of instruments has been submitted to the Medical Officers of Health Committee; a direct request for its early acceptance has been sent to the Metropolitan Boroughs' Standing Joint Committee. For other measurements in the London area during severe smog, plans to enlist the co-operation of the Civil Defence Organization are under consideration. Attempts are being made to develop suitable techniques for use in such an exercise, including some 'spot-tests' based on methods developed at the Chemical Defence Research Department.
>
> " Weekly samples of smoke recovered by means of an electrostatic precipitator from the air entering the Houses of Parliament are being collected regularly for examination and analysis. At times of severe fog samples representative of each day's yield will be obtained separately.
>
> " A small-scale electrostatic precipitator has been assembled for various laboratory investigations. For the collection and analysis of smog particles coarse enough to settle from the atmosphere a stainless steel funnel approximately 1 sq. yd. in area has been set up.
>
> " *Effects of Air Pollution on Health (Co-operative Investigation) Lung Cancer.* As part of an investigation conducted by the British Empire Cancer Campaign, ten instruments

for the measurement of smoke and ten for sulphur dioxide have been set up in the Liverpool and North Wales area where there are considerable differences in the incidence of the disease. The measurements of sulphur dioxide and total smoke and the inorganic analysis of the smoke are being undertaken by the Fuel Research Station.

" *Bronchitis.* An investigation is being made by the Treasury Medical Service and a London Hospital into possible connections between air pollution and chronic bronchitis. The Fuel Research Station has undertaken to supply about 30 instruments and to operate and carry out the analyses from 15-20 instruments installed in the London area. The first of these instruments are now being installed.

" *Aetiology of Respiratory Disease in relation to Atmospheric Conditions.* A study group has been set up, under the Chairmanship of Professor Bradford Hill, by the Medical Research Council and the London School of Hygiene and Tropical Medicine, to investigate possible statistical relationships between atmospheric conditions and the incidence of respiratory disease. The Fuel Research Station is represented on this group and various data are being extracted from the records of the Department for their consideration. The group is also interested in the investigation of a possible connexion between smog-mortality and pollution.

" *Emergency Air-purification Units.* Two simple outfits have been developed and assembled at the request of a London hospital for removing air pollutants from hospital wards. One of the outfits removes sulphur dioxide only, the other both sulphur dioxide and particulate matter. The hospital, which has commented favourably on the performance of these outfits, has been asked to consider whether such units would be useful for emergency use in hospitals during periods of smog."

It will be realized from the above statement that the question of atmospheric pollution is being taken seriously by the Fuel Research Board and many other responsible bodies.

One cannot discuss the smoke nuisance without mentioning the use of coal on our railways. We are to be shown a film, during these meetings, demonstrating the care with which many engines are maintained, helping to maintain their efficiency in the use of coal—and their power—and to reduce the smoke nuisance. This is all to the good but out of the nature of things the railways use much more coal than the nation can afford. Taken all in all the overall efficiency is less than six per cent and large cleaned coal is called for. This low efficiency is due to many causes. Fires are burning when the engines are standing in stations—when in the engine sheds or otherwise waiting to operate before or after their journeys, etc., etc. The remarkable difference to the ordinary man in the street is seen when comparing the Southern Railway with those in the North. Some alleviation has been obtained through the limited use of diesel motors in shunting yards and for short distances on branch lines when oil is being used only when the motor is in motion. The electrification of the whole of the railway system would solve this smoke nuisance and only the power stations would have to be watched. Apart from this the latter can use coal that cannot be used on the railways and with greater efficiency for the same amount of work done. The change over will continue gradually to take place but the capital costs in the first instance will be great—but I am sure it will be worth it when all factors are taken into account.

Neither should it be overlooked that the Oil Companies through their research organizations are continually carrying out investigations on subjects closely affecting the efficient use of oils and atmospheric pollution—but very much more requires to be done not only in connection with the proper use of and design of diesel engines but also in connection with the enormous extension of motor traffic using petrol.

Pollution from Vehicles

It should not be overlooked—and this may be considered far fetched—that if combustion in all motor

vehicles were perfect and exhaust gases contained nothing but nitrogen, carbon dioxide and water vapour this would still reduce the amount of oxygen available for breathing by the human being to a serious extent under conditions of congested traffic in our cities of relatively narrow streets, high buildings and fog conditions. But theoretical conditions can never be relied upon although much can be done by improved design and adequate maintenance of motor engines and more consideration on the part of the drivers.

Intermittent or periodic visible smoke exhausts from motor cars and diesel motors must be reduced to the minimum and I believe the time will come when it will be the duty of all owners of motors to have their engines checked regularly and tuned to give the best results. It would often pay the user as it would save fuel. In passing it should not be overlooked that a diesel engine uses about 25 to 30 lbs. of air per pound of oil as compared with 15 lbs. of air per pound of petrol in a petrol engine. Hence the volume of exhaust gases from a diesel engine is greater than with a petrol engine of the same B.H.P.

There is nothing more objectionable than the emission of the black clouds of greasy smoke emitted from so many diesel motors—especially when suddenly accelerating—or changing down, when climbing uphill.

A few days ago I had the following note from a reliable source which confirms one's own experience as a motorist.

> " I heard of a badly affected area the other day which I thought might interest you. The story is that diesel lorries are particularly bad offenders throughout the day and in the evenings on the stretch of road from Archway Underground Station up the hill past Whittington Hotel and as far as the Woodman. I am told that it is so bad that the local people are quite accustomed to holding handkerchiefs to their noses over this stretch when a string of vehicles is going by.
>
> " It occurred to me that if you did want to get a large sample of typical diesel-exhaust contaminated air this might be a good area to prospect."

He added that this was so bad that some people preferred not to walk on the left hand side of the road and that although it was a busy road would walk across to the other side!

The following two letters appeared in the press recently:—

> " From a wood near Trowell, selected as the typical village for the Festival of Britain celebrations, my sons and I, two years ago, collected 7 lb. of raspberries for jam-making. The wood had escaped destruction by industry but was surrounded by machinery using diesel oil. During cooking the jam a strong smell of diesel oil arose, and the scum from the top was nauseating. Our dog, who usually eagerly devours such scum, refused it. Fortunately the oil was all removed in the scum and the jam beneath was excellent."

> " Sir,—As a window-cleaner in the Chelsea area, I have first-hand experience of the filth caused by diesel buses. There is one house I sometimes visit in Beaufort Street where, until a few years ago, the windows caused me little trouble ; that is, when there were still trams on that street and no buses. Now there is a bus stop immediately outside the house, and the windows get covered in a greasy film, and are very difficult to clean."

Many private motorists—I among them—resent the fact that when driving one's own car through diesel smoke, normal methods of washing and polishing are not sufficient to remove the greasy oil deposits that are found on it. Even if such clouds can be shown to be non-poisonous, and they have not, they must inevitably do harm to one's lungs. The dust in coal mines is not in the accepted sense poisonous but it brings about the scourge of silicosis. I wonder what will be the ultimate effect of this offensive pollution on health.

I have said quite enough to convince you that I hold the view that there is room for a material improve-

ment in connection with the development of diesel design and usage.

The Society's Influence

It is interesting to speculate how much an organization like this Society actually influences public opinion and the progress of events, not only in its own subject but also in the wider subjects with which it has contacts. It is impossible to measure such influences, but the history of the Society, which with that of its parent bodies now goes back over fifty years, clearly shows how it first overcame hostility and derision for the idea of smoke prevention, then turned apathy into approval, and is now leading an active movement towards the realization of its goal. The steady growth of the Society in membership and influence over the years has been helped by events and changes outside itself, but the Society has always seized upon these things and used them to help it develop its case. Without the Society the case would have often gone by default and there would not now be the clear, practical programme for reform that has been developed. Such a programme must depend upon many people having a conviction that it is necessary and an understanding of what is involved—and it is here perhaps that the Society's influence has been greatest.

This influence has been largely one of steady, persistent permeation, for the Society has always been denied the opportunity through shortage of funds, for the mass attack and publicity on a big scale. Though it is difficult to summarize the growth of this influence some of the outstanding features of the long campaign can be picked out, and it may not be without interest, especially for our newer members, to refer to them here.

The work of the Coal Smoke Abatement Society, mainly in London, from 1900 to 1920, was sheer hard pioneering. But it led to the appointment of the Newton Committee, the report of which was the ammunition needed to press for the new legislation that eventually came into being as the Public Health (Smoke Abatement) Act, 1926. Disappointing though many of the results of the new law may have been, all credit is due to the efforts of a very small group of people, led by the late indefatigable Dr. Harold Des Voeux.

At this time, and during the 20's and 30's the two older bodies, in Manchester and London, and then the present Society after their amalgamation, worked with steady success to awaken the local authorities to a recognition of the importance of smoke prevention and of their responsibilities in the matter. That work is not yet complete, but it has gone a long way, and we welcome the moral and financial support now given to us by so many authorities—now over 450. (Of course we wish their financial support was as great as their moral support!) A more recent, and equally welcome, development is support from industrialists, limited in number though this is so far.

And what about the Society and the domestic grate? One may refer to the important development of the new, more efficient types of open fire, which were designed originally simply to enable *coke* and other *solid smokeless fuels* to burn brightly and efficiently. The first improved fires, in the 1930's, were designed and promoted by the gas industry as their response to a need that was beginning to grow as a result of the increasing criticisms of the old-fashioned inefficient coal fire. In those days the coal fire was not criticized because it was so inefficient and wasted so much coal, but simply because of the smoke it emitted. And the chief critic—indeed at first the only critic—was of course the Society. We can claim therefore that the start of the research and development that has led to the mass production of improved appliances was due in a large measure to the persistent, and in some circles often unpopular, activities of the Society.

Then comes the growth of the original idea of progressive smoke

prevention by means of smokeless zones. Tribute has been paid on other occasions to our former chairman, the late Charles Gandy, for this conception, and here one need only emphasize not just how successful the principle is proving to be in practice, but how right Gandy was in his conviction that a concrete example of smoke prevention, in a form that could be seen and understood by everyone, would fire the imagination of the man in the street and secure his support for further measures.

We have had the " Well " grate, the semi-well grate and the flap-adjustable hood, and latterly, after many exhaustive tests by the Fuel Research Board, many thousands of adaptable grates have been installed in existing fireplaces fire brick lined—some with gas ignition—and all with adjustable combustion air control. These were specifically recommended for suitable coke and other solid smokeless fuels.

I fear, however, that most are used for coal burning and bring about little, if any, reduction of smoke. Their attraction, with coal, is that a small slow burning fire can be maintained—if necessary—over night whereas with coke it is difficult to have a small fire and very few can be kept in over night.

Much more requires to be done in development if the open fire is to be relatively smokeless when using coal.

It has been suggested that the entrance to all fireplace chimneys in new construction should be standardized as regards height from the floor and dimensions so that new fireplaces or gasfires or closeable stoves can be fitted at the choice of the householder—the heating device being no part of the structure of the house. I commend this proposal—but that of itself does not solve the problem of the development of a smokeless open fire when using coal.

A now-forgotten booklet of the Society, which few at this conference will have seen, was entitled *Smoke Prevention in relation to Initial Post-War Reconstruction.* It was a memorandum submitted to the Minister of Works and Planning and the Minister of Health in the dark days of 1942, when, despite the anxieties of a war, still far from won, the nation was beginning to think about the aftermath. It concisely put our case in the way we still put it—and incidentally called for the establishment of a Ministry of Fuel. There is little doubt that this timely document and other publications of the Society influenced the planning experts and committees whose reports since then have devoted so much attention to smoke prevention—the Housing Manual, the Egerton Report on Heating and Ventilation, the Simon Report on Domestic Fuel Policy, and the Ridley Report on Fuel Policy. These in their turn have profoundly influenced government, local authority, industrial and technical opinion about the importance of smoke prevention, and in their turn these no doubt influenced the Beaver Committee to say without hesitation, in their interim report : " Sufficient is known already about the causes, effects and cure of air pollution to enable the broad problem to be appreciated, measured and largely tackled ", and " The causes and remedies of pollution by smoke are known : the problem is one of practicability and economies, and of the education of the whole community."

In this brief selection of the achievements of the Society it can be mentioned—for it may be in danger of being forgotten—that the Society and its parent bodies were the first to recognise the importance of good, intelligent stoking in industry and to organize and press for the training, examination and certification of stokers. This work was being done, for smoke abatement, long before it became necessary to do it for fuel efficiency—the earliest record we have been able to find being of classes organized under the auspices of the Coal Smoke Abatement Society at the Borough Polytechnic in 1907. Today we see, largely as a result of our efforts, the organization of courses and examinations by the City and Guilds

of London Institute, with a new Boiler Operators' Certificate—in effect the national certificate desired by the Society—for which this summer no fewer than 637 candidates have sat.

In order to help in the education of the general public our Society through its regional sections holds many conferences and holds joint meetings with the eight sections of the Institute of Fuel annually on some phase or other of atmospheric pollution—health, vegetation, corrosion and fuel conservation.

The Present Conference

This conference, I am sure, will stand out as the most important one the Society has held. We are fortunate in having as the Des Vœux lecturer Sir Edward Salisbury, Director, Royal Botanic Gardens, Kew. We also have Sir Hugh Beaver, the Chairman of the Air Pollution Committee.

I have never known any committee to be so thorough, so competent and so expeditious in their work as the Beaver Committee. It is in some ways fortunate that there are not many such committees otherwise I fail to see how time could be found for carrying out other essential work for the rest of the community. We look forward to reading the further report or reports that are forthcoming from his Committee.

We are also fortunate in having Dr. W. A. Macfarlane to take the Chair at one of our sessions. As is well known he is Manager of N.I.F.E.S. —the National Industrial Fuel Efficiency Service. He has a big job to tackle. His organization belongs to industry. He is extending the work of the Fuel Efficiency Committee of the Ministry of Fuel and Power and has taken over a number of the staff of the Ministry. This ensures the necessary continuity of the work. It is a big job and deserves the maximum support from all concerned with industry.

The Society

Now what of the Society. It is limited by the smallness of its annual income. We hope to get substantial Government support. Prior to the last election a request for this was made to the Lord Privy Seal. He referred the appeal to the Ministry of Fuel and Power. It was considered by the Ministry that the Ministry of Health was the appropriate Ministry to deal with the matter and after many months it was referred back to the Minister of Fuel and Power who then appointed a Committee to scrutinize the appeal and it was recommended that it should be supported. The Ministry forwarded the appeal with sympathy to the Treasury and we heard nothing more about it—the General Election coming soon afterwards. We are still living in hopes—but the Society cannot do much more on 5 to 6 thousand a year income.

In the meantime we have acquired more office accommodation and appointed a further member of the staff, some of whom are inadequately paid. In spite of this the output of the staff—and particularly that of the Director, Mr. Arnold Marsh—is commendably high in quantity and quality. We are proud of our Journal " Smokeless Air " and the Year Book is chock full of useful information. Apart from this the Director gives many lectures in different parts of the country and attends meetings of committees of other bodies on which the Society is represented. One cannot speak too highly of his work which largely accounts for the success of our activities. There are seven very active local Divisions, working with little money but under the direction of real enthusiasts.

I estimate that with an income of £20,000 a year we could perform wonders in education and propaganda.

Industry is taking more notice of us but we should like more firms to show their interest in a really practical way. It is coming but it can be speeded up by each of our members using his influence with the firms with which he is in intimate contact.

This year Mr. Arnold Marsh has been appointed Director of the Society and Mr. Victor R. Silver its Secretary. Thank you both and also the officers

of the Divisions for what you have already done and what you are doing today.

It is useful to look back at what has been accomplished, not only to give ourselves an encouraging pat on the back, or to tell the world how right we are, but to give us confidence and direction for the tasks ahead—very shortly the next Beaver report will be out, and will, we are confident, give to the Society the biggest impetus it has yet had for continuing to press forward, with increased vigour, to further the revolution we claim to have started.

I cannot do better than end this address by quoting some words of Dr. L. P. Jacks, the distinguished former Principal and Professor of Philosophy at Manchester College, Oxford, and editor for many years of the " Hibbert Journal "—

> " From all destroyers of natural beauty in this parish and everywhere ; from all polluters of earth, air and water ; from all makers of visible abominations ; from jerry-builders, disfiguring advertisers, road-hogs and spreaders of litter ; from the villainies of the rapacious and the incompetence of the stupid ; from the carelessness of individuals and the somnolence of local authorities ; from all foul smells, noises and sights—Good Lord, deliver us ! "

ADDRESS

by

SIR HUGH BEAVER

Chairman of the Committee on Air Pollution

I AM very pleased to be here; this is by no means my first visit to Scarborough but certainly my first visit to one of your annual conferences. I am honoured to have been invited to address you because I suppose I have spent a shorter time of my life dealing with this problem than almost everyone else in the hall.

You will appreciate that I am in a somewhat embarrassing position. The Air Pollution Committee has virtually finished its report and it is a mere matter of weeks now before it is put in its final form into the hands of Ministers. Obviously it would be improper for me to anticipate what that report will contain; even more so it would be improper and impossible for me to attempt to anticipate what may be thought of that report by the Government, or the public, or by industry; or what action they may decide to take. So I know you will appreciate my position and forgive indefiniteness, if that is what you find me guilty of, in this direction or that. It would have been much easier and perhaps much wiser to have asked you to allow me to postpone for a year meeting you; but I am so certain that this is a matter in which public opinion above all is important, and that your Society has done so much in educating and leading public opinion on this matter, that I felt it was my duty to come and lend whatever support I could to your efforts particularly on this particular occasion.

You will have seen, though perhaps by now you will have forgotten, my Committee's Interim Report. I do not think that it would be indiscreet of me to say that nothing that we have seen or heard or learnt during this year's intensive investigation has in any way shaken our conviction in the general statements that we made in that Report. We referred to the colossal annual cost to this country from the pollution of the air. We have given a lot of attention to this. We established a special sub-committee to devote its time to considering a reassessment of the cost to the nation as a whole and I may say that we are satisfied that no figures that have been hazarded in the past really, in our opinion, overstate the case.

In the Interim Report we gave some mortality figures based largely on the London smog incident. As we proceeded we have been more and more impressed by the seriousness of the health aspect of air pollution as a whole, but we have been handicapped by the paucity of definite knowledge in many directions. What is undeniable, in our opinion, is that two-thirds of the population during all their lives live in conditions which are a long way short of what is essential to perfect health.

We stated in our Interim Report that so far as smoke was concerned cures were known; the only question was the best practical steps and the will to carry them out. That remains the position except that we in our Report are making very definite proposals for action. Pollution of the air by smoke can be cured—of that there can be no question—but let no one think that it is a matter that can be done overnight. It is a long-term business as the long history of your Society has already proved. By that, however, I do not mean it is a matter of generations. My Committee believes that a very pronounced effect can be

secured within ten years. We stated in our Interim Report that it would cost money but that any such expenditure would be a very profitable national investment. We are all the more convinced that that is so.

I would like to direct your thoughts for a moment or two to this last point. It is so easy to make a broad sweeping general statement like that. We on our Committee believe that it is pretty well demonstrable and undeniably true; but there are no mechanics for the actual direct appropriation of the savings that would be secured so as to provide the funds to cover the remedial actions. It is only in some nebulous National Ledger that all the sums will ultimately be debited and credited; and meanwhile it is difficult to see how we can do other than let the savings accrue to industry, to commerce, to art and generally to all dwellers in the populated and industrialized areas—while, on the other hand, the cost has to be met, if it is going to be met, out of the national exchequer, out of the local rates and out of the individual pocket. So far as the National Budget goes, then, the entries are all on one side, and that makes obviously a somewhat vulnerable and tempting position if ever a Chancellor of the Exchequer should find himself in a difficult position. There may be some better solution and that is a problem to which I believe you could well devote some thought. For ourselves we do not see that there is any easy means of meeting the cost except on those lines—in fact, I may say not only easy, but practical. In this, public opinion is the ultimate arbiter as to whether the cost of curative action is to be accepted or not. Without some pretty heavy expenditure there is no worthwhile cure. Are we all as the whole country sufficiently serious in our views, in our complaints and in our protestations, to face this heavy expenditure?

That leads me to the question of public opinion. Now I do not like, and I'm sure you don't like, the word propaganda; and to talk of educating the public always seems to me to sound rather condescending. Who are we to claim the right to educate our fellow citizens? And yet clearly something has to be done, something more than has yet been achieved. The history of the attack on air pollution in some of the cities of the United States is notable, in that it was often the pressure of an irritated public opinion that secured action. It was neither the Federal nor the State nor the local government that initiated action. The vast research work which is now being carried on at Stanford University into the Los Angeles smog problem is financed and directed by private interests—largely by industry. I do not say that that is altogether necessary in this country, for here we have for some time had a form of Government and a public outlook both official and individual which in latter years at any rate has been ready always to accept Government action in the interest of general welfare. We may perhaps, some of us, sometimes feel that this attitude can be too pronounced; but by and large the attitude is right. Nevertheless, no Government, central or local, can ever be very far in advance of public opinion. And public opinion is a very elusive factor. The representatives of the public in Parliament or on the local council do not necessarily, I venture to say, always represent public opinion, especially incipient public opinion; the newspapers that the public buy do not, as we have often seen, voice public opinion—at least until the public gets angry or deeply stirred on some matter. Public opinion has not yet forced effective action in regard to road safety. Will it be any more effective in regard to air pollution? The trouble is that, if we are honest with ourselves, we all play two parts; we, you and I, are the citizen with strong feelings as to public rights and the common weal, and we are the individual with our own personal likes and idiosyncrasies. We demand action to save life on the road, but invariably, I imagine, deny when stopped by the police that we ever exceeded 30 miles an hour in a

built-up area, or crossed on the orange light. We subscribe perhaps to the Smoke Abatement Society, and enjoy our open coal fire. Now I am not being facetious. I want to point out that there is a great problem here to secure that there shall be such pressure of public opinion as will both demand and make possible action to cure air pollution, and what is more will accept the results of such action, which will affect pretty well every individual in the country. This again is a matter in which your Society can play a big part, bigger even than anything you have yet done. I think we are still a long way from knowing the best methods—or all the methods—of getting this vitally necessary mobilization of public opinion. What a share, for instance, the doctors and the schools could bear in this.

Now in dealing with this educational and publicity work there is one thing that I think we must bear in mind—namely that there has been much too great a tendency, at least in my opinion, to emphasize individual incidents and the effects of bad smogs. A smog—and I don't apologize for the word—such as the London December smog of 1952 has, of course, good news value. My own Committee has been constantly and caustically reminded by the Press that we were, so it was suggested, fiddling along while December 1954 with all its tragic memories and threats was rapidly approaching. I have never complained of such attention from the Press—not that it would have made the slightest difference had I complained—but I have never complained because I do feel that anything that helps to keep public attention on this subject is worthwhile; and I would only hope that the Press will equally support action when it is recommended and comes to be taken. But it is in my opinion—and I believe in yours—wholly wrong to look on this air pollution, this air pollution menace, merely in terms of periodical or occasional abnormal concentrations. The loss to this country in health and wealth and efficiency is a continuing process. The London smog laid dramatic emphasis on what is going on all the time. A good deal of attention has been given to trying to calculate or to guess the strength of the particular concentration that proved lethal, or the particular element or elements or components that were the real cause of that exceptional disaster. What, it is said, is the most lethal? It is important to know that, but what is much more important, and what in my opinion requires no further proof whatsoever, is that smoke and dust and grit and sulphur are all deleterious and an intolerable nuisance, even when they are not an immediate danger. People are entitled to clean air, as they are to clean water; and they should demand it.

One of the best ways by which public opinion, I believe, can be effective is by the development of a civic pride. My Committee as we went round were struck by the differing attitudes of various Authorities that we saw. I am not referring at the moment to those overworked and most efficient officials, the Sanitary Inspectors, but to the Councils; reflecting I do not doubt, in very large measure, the awareness or the apathy, as it may be, of the man in the street—though perhaps not so well reflecting the attitude of the woman in the home. Now in some of the places we visited there was a clamour for action that I can only describe as infectious; in other places we found signs—very proper signs—of self-congratulation—in other spots, of envy—in regard to the establishment or proposed establishment of smokeless zones. That smokeless oasis in the centre of Manchester, or the clear white of Nottingham's smokeless suburb of Clifton have an effect on many others than their own citizens. The long-drawn, laborious, detailed, difficult survey which Glasgow has been carrying out in order to arrive at practical boundaries for its first smokeless zone—that has in it both a lesson and an encouragement. But as we went round we did not everywhere find the same enthusiasm, or the same accept-

ance of the challenge of smoke. There is much work here to be done. But let me say this, that—speaking for myself, but I believe also for my Committee—we would wish, I would wish, to emphasize that the spearpoint of the attack is the local authorities, and on them must always lie the main burden, both individually and in joint action.

I imagine that your Society has not yet had time to consider and work out all the implications and possibilities that are created by the establishment of the new National Industrial Fuel Efficiency Service. It is of course wholly directed *at* Industry and is fully endorsed *by* Industry, at least Industry as a whole. N.I.F.E.S. is bound to emphasize that its objective is fuel efficiency. It is possible to produce, I suppose, particular cases where there might be, or might seem to be, some conflict between efficiency and smokelessness in the use of fuel. But such occasional and theoretical conflict should not be allowed to obscure the real fact, as your President pointed out this morning, that the efficient use, and the virtually smokeless use, of fuel go hand in hand. I conceive, therefore, that on the industrial side there is a big part for N.I.F.E.S. to play in smoke abatement. And it seems to me that there is scope for considerable co-operation between your Society and N.I.F.E.S. in matters of publicity and in other ways.

The title of your Society is the Smoke Abatement Society. I have been talking largely of smoke and the main part of my Committee's forthcoming Report deals with smoke and dust and grit; but that does not mean, as your President pointed out, that either you or we forget for one moment that smoke is only part of the problem, though we believe a very major part. The menace of gaseous pollution is real, but unfortunately neither on the medical side nor on the technical or chemical sides have we yet the knowledge on which to base firm comprehensive proposals or to secure effective overall action. There is a great deal of investigation and research still required and every effort needs to be made to stimulate such in all directions, because without knowledge you cannot act surely.

Now I have ventured to put these two or three points before you, because whatever the contents of my Committee's Report, and whatever action is taken on it, these matters are within your own knowledge and your own liberty; and they are all important.

For the rest I must leave it to the Report, which I trust you will find, at least to some extent, up to your hopes; and if so, due credit must be given to you who have given us such valuable assistance and evidence.

And now, finally, may I just take this public opportunity to pay a tribute to my colleagues on the Committee? Few people, I believe, can have voluntarily worked so hard in the public service as have some of them; and we are too indeed grateful to the assessors and officials who have helped us throughout and who are, if I may say it, as representative a sample as one could wish of the finest Civil Service in the world.

Discussion

Dr. W. R. Martine (Chairman, Executive Council) in opening the discussion, said it was indeed unfortunate that Sir Hugh had had to address the Conference before publication of the final report of his Committee, for we could not do more than be complimentary about the Interim Report, published in December last. We could not tell him now what we might wish to tell him in a few months' time. He claimed that he had had no easy task, yet we must agree that he had done nobly in the circumstances and we might hope that what he had said would receive the press publicity it deserved. In that way alone, he would have done us noble service in our fight for Clean Air.

Dr. Martine thought that he had the

more difficult task—to try to read between the lines of Sir Hugh's address and to sway him, perhaps at the eleventh hour, on some point where he and his Committee might not feel as strongly as we did. He had asked us what steps should be taken to clean the air and we had given him our views as to what could and should be done. He had also referred to the financial means whereby such steps might be taken. The Society believed that if there were sufficient public demand, the money would be found, whether by way of grant or incentive or whatever means the financial experts found possible. In this connection it was appropriate to draw Sir Hugh's attention to the papers given by Mr. Mather and himself at Portsmouth two years ago.

Sir Hugh was entirely right when he said that public opinion was the really decisive factor. He had expressed a dislike of the term education where the public was concerned, yet the term "Health Education," perhaps for lack of a better, was one accepted by local authorities and the public as part of a local authority's function. The case for Clean Air was not, however, universally included in the local authority Health Education programme and the lack of knowledge in this direction was still appalling. The average citizen still wished to lay all the blame upon industry, disregarding the discharge at low level from his own and from his neighbours' chimneys.

Sir Hugh had justifiably criticized the tendency to emphasize particular incidents and to forget the day-to-day pollution from which we had suffered for so many generations. We certainly could not complain of lack of press publicity since December, 1952—with the London smog and the Beaver Committee in session that was inevitable—but what of the years before that? A big splash at the time of our annual conference and then oblivion, apart perhaps from an isolated comment in the local press following a meeting of one of our regional committees. Much more could and should have been done to stir up public opinion, but we must face the facts here: we in this Society could not for financial reasons alone do more than a fraction of what we wanted to do. We were moreover labelled as cranks flogging a dead horse in opposition to the slogan about muck and money, and frankly we had not been news.

Sir Hugh and his committee clearly accepted the deleterious nature of smoke, yet they had been disappointed at the lack of scientific knowledge available as to lethal concentrations either of smog or of its individual ingredients, singly perhaps, or in combination. Medical research now in progress should be centrally planned and co-ordinated. It should be expanded moreover, because while medical opinion as to the effects of smoke might be unchallenged, it was, at the same time, strikingly unsupported by statistical evidence either as to respiratory effect or the effect of loss of sunlight. Research again into the relation between diesel and petrol fumes and fogs in our congested areas was long overdue.

As regards N.I.F.E.S. he had only one comment to make. For some years now, in spite of the figures given, which when taken for the country as a whole did not mean very much, only a handful of stokers had attended the courses arranged by the various Fuel Technology Advisory Committees throughout England and Wales. While there were undoubtedly many enlightened employers in industry it seemed impossible to obtain agreement between the representatives of employers and the representatives of the employed on this vexed question of tradesmen's status and tradesmen's rate of pay for the qualified stoker. Yet representatives of industry, when arguing against the policy of prior approval, also put forward the plea that modern plant needs no approval, that the stoker was always to blame for any smoke emitted. It was hoped that Sir Hugh's committee would come out very strongly on this question of

training and qualification of stokers; whether they laid the emphasis on fuel efficiency or smokelessness would seem of little importance.

For the rest, Sir Hugh trusted that we should find the report up to or closely up to our hopes. We might not get all we had asked and we must not forget that the report in itself was not the final answer. We hoped, however, that quicker and more effective action would be taken to implement the recommendations of the Beaver Committee than had been accorded to similar reports in which we had been interested in the past.

Dame Vera Laughton Mathews, after paying tribute to Sir Hugh Beaver and his Committee, stressed the great effect on Smog of domestic smoke. Having regard to the fact that there were approximately 15 million open fires in this country, it was evident that the immediate key problems on the domestic side were the supply, quality and price of solid smokeless fuel, and the will to use it.

Natural smokeless fuels being at the present time in short supply, they must be realistic and face the fact that the one solid smokeless fuel in good supply and likely to have a marked effect on solving this problem was coke in all its various forms. In fact, until the atomic age, and perhaps even then, there could be no economic solution of the domestic smoke problem except by coke—which, at the moment, was being priced off the market; was being largely allocated for the purposes other than domestic; and about which a number of fantastic legends were in common circulation to the detriment of its use.

Dame Vera said we would endeavour to explode the great coke myth. Quite recently, in one of the largest and most famous Stores in London, she was making an enquiry about her stove, one of the closed, openable variety. On being told that she burned coke, the manager of the department was openly horrified; informed her that she was exceedingly fortunate in having escaped a fatal accident so far; and said that although not a scientist himself, his definite instructions were to inform customers that it was dangerous to burn coke alone on these stoves. This ridiculous statement was only to be compared with the other view widely expressed that coke lets off fumes which coal does not.

What was the truth? Obviously, if a chimney was blocked—by a bird's nest or such—the fumes from either coal or coke could not escape up the chimney. With coal, the room was filled with smoke as a danger signal, and coke did not have smoke. It was farcical to imagine that coke, which was coal from which gas and tar had been extracted, could possibly have any poisonous fumes which were not in raw coal. It was just one of those things which got repeated without thought.

With regard to the question of supply, more could certainly be made available for the domestic market now, and progressively more in the not too far distant future. Of the 11 million tons of coke made available each year by the gas industry, only one-quarter found its way to the domestic user. Taking solid smokeless fuel as a whole, the proportion was very much smaller. The remainder went to industry or for the heating of commercial or public buildings, which had larger installations on which it was more possible to burn coal smokelessly than on small domestic fires. Although domestic coke was off the ration, it still had to be marketed as the Ministry of Fuel dictated, and if Smoke Abatement was Government policy it was surprising that the domestic market did not have first call on coke supplies.

In the important matters of quality and price, it was difficult for those responsible for coke not to put all the blame on the National Coal Board. Certainly if the Government were sincere in their wish to promote Smoke Abatement it was strange that under the coal price structure there was a higher rate of increase for coking coal

than for any other class. One imagined a Ministry in which the Smoke Abatement supporters sat in one Department and in another, apparently in no contact, were the theoretical economists, blissfully working on the old principle that if a commodity was in short supply, the price should be put up until the demand went down—quite irrespective of whether that demand was essential to the best interests of the country.

Coke quality, continued Dame Vera, also depended largely on the quality of coal, though the producers of coke must bear part of the responsibility; grading plant was an essential part of the domestic marketing of coke and it was also important that the right kind of coke for the specific purpose should be supplied. The coking industries were alive to their responsibilities and within limitations of permitted capital expenditure were endeavouring to put the situation to rights. New coke marketing schemes were being put into operation which provided a consumer advisory service by the producers in full co-operation with the merchants.

But when all was said and done, the first essential was to spread the idea that it was wrong to burn bituminous coal on open fires. It was useless to sell millions of improved grates designed to burn coke if their owners insisted on burning raw coal in them, with no increased efficiency or heat output—and, what was more, banking them up for the night—a most efficient way of producing smoke, and why, when there was such a thing as a gas poker?

Dame Vera said she honestly believed that innate hatred of change was at the root of the matter. People thought they must see a flame or something, but if they tried doing without they would find that life went on just as happily—or unhappily, according to which side of the bed they get out. As an instance, there was the Clifton Estate, Nottingham—a large estate of 1,000 acres, where there was a condition of tenancy that no one should burn anything but smokeless fuel. Eventually there would be nearly 7,000 houses and it would be the biggest smokeless zone yet envisaged. She understood that at first there were murmurings among the tenants, but following a good consumer service and a supply of the right coke there was now complete satisfaction.

Sir Hugh Beaver had said that the Government could not move very far in advance of public opinion, and how true that was. But it also had a duty to lead, especially in a matter which—as the lecturer had said—affected the health, wealth and efficiency of the country—and she would add beauty as well, an addition of no small importance.

Meanwhile, public opinion was formed by Societies like this—by small groups of individuals who really believed and really cared. They had to face it, there was a great deal to be done. Until the next smog came, who really cared about Smoke Abatement outside the National Smoke Abatement Society?

And in helping to form public opinion, Dame Vera hoped the Society would not forget the resolution of the Women's Gas Federation which was accepted by last year's Conference, urging education through Women's Societies and Women's Programmes. After all, it was generally the woman in the home who had the last word as to what fuel was used.

Dr. C. F. White (Medical Officer of Health, City of London) said he had been asked to make a short statement on the subject of the powers recently obtained by the Corporation of the City of London, in the City of London (Various Powers) Act, 1954, to make the City of London a "smokeless zone," which, as would be realized, meant a non-smoke producing zone, because they would continue to get smoke drifting into the City from the vast area of the County of London surrounding them.

A few words on the history of the Corporation's efforts in this direction

might be of interest as showing how difficult it was to achieve substantial progress in smoke abatement.

From the time the City of London was devastated by enemy action in the years 1940 and 1941, the Corporation began to consider the rebuilding of the City. The contribution of a Medical Officer of Health to planning of such magnitude was very small, but following a meeting of the National Smoke Abatement Society in London on November 5th, 1943, he reported to the Public Health Committee on "Measures for the Prevention of Smoke in Relation to Initial Post-war Reconstruction," and recommended that the Corporation should seek statutory powers to require prior approval of heating arrangements in new and reconstructed buildings and to declare smokeless zones in the City; in accordance with the resolutions passed at the meeting of the National Smoke Abatement Society. The Public Health Committee, and subsequently the Special (i.e., the Policy) Committee of the Corporation, approved the recommendations, and the Corporation decided to seek such powers in their next Various Powers Bill. At the same time, the late Sir George Elliston, a former President of the Society and a member of the Corporation of the City of London, urged that a District Heating Scheme should be prepared for the rebuilt City.

What was the result of these efforts? A "smokeless zone" clause and a "prior approval" clause were, in 1945, included in a City of London (Various Powers) Bill, but there was powerful opposition to the "smokeless zone" clause, and as the Bill contained other clauses which the Corporation were anxious to get through Parliament unopposed, the "smokeless zone" clause was dropped. The "prior approval" clause, however, went through and was included in the City of London (Various Powers) Act, 1946 in the form of extended powers to make byelaws under Section 151 of the Public Health (London) Act, 1936, requiring the approval of the Common Council to be obtained before the installation in new buildings of heating arrangements of any kind, and before substantial alterations were made in the heating arrangements of any existing building. It was never found possible to frame byelaws which the Ministry of Health would approve. First of all the Ministry suggested that, owing to the difficult coal supply position and particularly the shortage of smokeless fuel, the time was not opportune for the making of such byelaws. When the particular circumstances of the rebuilding of the City were emphasized, the Ministry intimated that they would be prepared to consider, with a view to confirmation, a series of byelaws which were not open to criticism on the grounds that they were unreasonable in the light of existing conditions as to fuel supplies, or that they failed to give adequate and specific guidance as to the arrangements which would satisfy their requirements. The Ministry contended that the draft byelaws were not sufficiently specific, and we never succeeded in drafting any that were.

As regards a District Heating scheme for the City, the Corporation appointed a distinguished consulting engineer to prepare such a scheme, but again it was not found practicable to carry the scheme into effect. A supply of hot water from an electricity generating station, such as had been provided in Pimlico from the Battersea Power Station, was not available. Moreover it was obvious that the rebuilding of the City would not be progressively area by area but would be sporadic, a large building here, then another a considerable distance away; so that the Corporation would have been faced with the enormous expense of constructing a heat generating station large enough, or capable of expansion to a size, to meet an unknown future demand, and miles of pipes leading initially only to individual widely separated buildings.

So all their efforts came to nothing. Then in December, 1952, there occurred the disastrous smog over London,

which created a widespread and insistent public demand that steps should be taken to reduce the pollution of the atmosphere. The Corporation of the City of London decided that they would again seek power to declare smokeless zones in the City, and to include an appropriate clause in a general powers bill which they had in preparation in 1953.

This time the proposal was accorded an entirely different reception; it had an excellent press, there was little opposition, and what there was was faint-hearted and almost apologetic. The Bill passed through all stages in both Houses of Parliament, providing, on second reading, an opportunity for a general debate on atmospheric pollution. The Act received the Royal Assent on July 5th, 1954.

The City of London was a particularly favourable area in which to establish a smokeless zone. There was no heavy industry and comparatively little residential accommodation. The majority of the buildings were blocks of offices, most of which had central heating plants using coke or oil fuel. There were, however, a considerable number of old office blocks which had no central heating but had ordinary domestic coal-burning grates in the individual offices. There were others which had central heating on the lower floors, but individual heating by coal fires on the upper floors. Even in the centrally heated blocks certain rooms had coal-burning grates, often more for appearance then for heating purposes. All these coal fires produced a domestic smoke type of nuisance, which was rendered more obvious by the fact that they were mainly in the older buildings of three or four storeys which were surrounded by more modern, much higher buildings, so that the smoke never got away.

The Corporation came to the conclusion that it would be futile to attempt to define zones within the City which should be declared smokeless zones, and decided to make the whole City of 667 acres one smokeless zone.

The Act stated that as from a date to be fixed by the Corporation, which should not be before October 1st, 1955 " no smoke shall be emitted from any premises in the City." The penalty was a fine not exceeding £10 and a daily penalty not exceeding £5.

There was no general defence on the grounds that the " best practicable means " for the prevention of smoke under existing circumstances, had been used.

There were provided, however, two lines of defence, one in relation to the burning of an *authorized* fuel, and the other to the burning of *any* fuel which had been approved by the Common Council as suitable for the particular appliance, and burnt in accordance with approved conditions and during such period as had been approved.

In regard to the first of these lines of defence, an authorized fuel was defined as " Coke, Anthracite or any other fuel from time to time as being an authorized fuel by resolution of the Common Council," and it was a defence to prove that the smoke emitted arose solely from an appliance suitable for burning an authorized fuel and properly maintained and used, and so arose either by burning that authorized fuel therein, or by burning any other type of fuel because the authorized fuel was not available at the time and could not, by reasonable care and foresight, have been made available.

It was reasonable to provide that defence, because it was the intention of the Corporation to limit the authorized fuels to those generally recognized as smokeless fuels, and they might not be available at all times; and moreover it was possible that there might be a brief emission of a little smoke even with a smokeless fuel, when lighting up or stoking up.

The second of the two lines of defence was designed to provide that if an occupier had sought the advice of the Corporation in regard to the type of heating appliance he should

instal, the type of fuel he should use, and the precautions he should take by means of instruments or otherwise to check the emission of smoke, and if he had followed the recommendations of the Corporation, he should not be liable to a penalty if smoke was emitted occasionally. That was an encouragement to occupiers to seek prior approval of heating installations, and accordingly the Section of the 1946 Act, under which the Corporation may make byelaws in regard to prior approval of heating arrangements, was repealed. Even if an occupier had done everything humanly possible to ensure that the heating appliances in his premises were smokeless in operation, there might be an occasional emission of smoke through some unexpected failure in the apparatus, the fuel or the operator. The occupier had then contravened the law, but it would be unreasonable to impose the penalty which the law prescribed for such contravention.

The act enabled the Corporation to exempt premises from the application of the provisions of the " smokeless zone " section, or to postpone their application to any particular premises; and to contribute the whole or part of the expense necessarily incurred in the execution of works for the purpose of complying with the section; though, so far as he was aware, there were no premises which should be exempted permanently or temporarily, and in his opinion anybody who could afford to occupy premises in the City of London should be able to afford to instal smokeless methods of heating. The section also laid down the means by which disputes between occupier and owner as to responsibility for the cost of necessary works should be settled.

Railway locomotives were specifically exempted from the application of the Act.

As regards the implementation of the powers, Dr. White said he was of the opinion that there should not be any serious difficulty so far as the open fires in the older offices, or what he might call the " amenity " fires in the modern offices were concerned. The cost of conversion to gas or electric fires or to modern grates or stoves capable of burning any type of smokeless fuel would not be a serious matter, and the greater efficiency would result in lower fuel costs, so the capital outlay on conversion would soon be repaid. There would be no objection from the Corporation to the burning of smokeless fuels of the Coalite type in the existing grates, but from the occupiers' point of view it would be more economical to instal an approved modern appliance.

The burning of bituminous coal and of oil in central heating plants would need more care than it had received in the past, but the difficulties were not insurmountable. They had had quite a lot of trouble from coal-fired plants, even with automatic stoking in modern buildings. In some cases at least that had been due to the variable quality of the coal supplied, though of course it had, since the war, become usual to blame the quality of the coal whenever there was complaint about the emission of smoke.

The petitioners against the Bill had pressed them to include oil as an authorized fuel but they had refused to do so, because an oil-fired plant could make the most filthy smoke. He was inclined to think that the manufacturers of oil-firing plant had not yet tackled the problem of absolute smokelessness. They had felt that they could keep well within the legal limits for smoke emission, but, so far as the City of London was concerned, they would in the future, have to achieve a standard of no visible smoke at any time. There seemed to be a problem in relation to commercial buildings which were centrally heated by oil-fired plants. Over the weekend the buildings were unoccupied and therefore the heating was cut down. During that period there was an accumulation of oily soot in the flues, and when full heat was turned on on Monday morning it was blown out and fell in the vicinity like black snow.

This was perhaps not atmospheric pollution in the strict sense and the actual emission took place in the early hours, perhaps in the dark when there was nobody about to observe it. They got the complaints about the oily deposits on flat roofs and skylights. He had also observed a relatively small automatic, thermostatically controlled, oil-fired plant which gave a short burst of smoke every time the burners lighted up. These points required attention and he would be glad to hear comments during the discussion.

Finally, said Dr. White, what benefits did they expect from this legislation, seeing that the City was only a square mile in the centre of London? Of course the smoke from all round would be blown over the City according to the direction of the wind, but at least they expected to be free from the heavier smoke particles which fell within a comparatively short distance of the point of emission from a chimney. Moreover, in foggy weather there was usually little or no lateral movement of air, and therefore they hoped that, because they were not producing smoke in the City, their fogs would not be " smogs." The reports from the smokeless zone of just over 100 acres in central Manchester were encouraging, and they were very grateful to Manchester, not only for that encouragement, but also for their help in the preparation of their Bill and during its second reading and its Committee stage. Manchester was extending its smokeless zone, the City of London had gone to its boundaries and must depend on neighbouring local authorities for any extension. They had a more difficult problem, but they sincerely hoped that they would tackle it in the near future.

Professor F. C. Pybus, F.R.C.S. (Newcastle upon Tyne) said that if one tended the plants in a town garden the hands became blackened by tarry material which was difficult to wash off; that one could, and so did, was the safeguard against cancer of the skin. But one was unable to wash such material from the lungs and therein was the reason why so many did get cancer of those organs. That such sooty substances reached the lungs was abundantly apparent in the post-mortem room, where the blackened lungs of the town dweller were a common sight.

Percival Pott made the fundamental discovery concerning the cause of cancer. In 1776 he published his account of cancer of the scrotum in chimney sweeps. He recognized that soot, accumulated in the skin folds, contained some factor which caused cancer of the skin. Since then other substances had been found which acted in a similar manner, and such cancers occurred in tar workers, those in the shale-oil industry and amongst mule-spinners.

After some unsuccessful efforts, it was not until 1914 that skin cancer was produced by tar in the experimental animal. Chemical research had isolated certain cancer-producing substances from soot and tar, the best known being the carcinogenic hydrocarbon benzpyrene. This had simplified recognition of the possible cancer-producing properties of many substances, and had greatly helped cancer research in experimental animals.

None knew better than the members of the conference about the pall of smoke and the amazing deposit of soot over their cities. In 1952, Newcastle upon Tyne had 205 tons of solid material deposited per square mile, with 3,646 tons for the whole city, with a tar content of 25 tons. The tar was of special interest to those concerned with the cause of cancer.

Greater precision in the matter of cancer-producing material had been given by Mr. Waller, who measured the benzpyrene content in the air of certain towns and cities. The amount was very small but at each breath they took in some 500 cubic centimetres of air, and that 15 times a minute. Thus even if that amount were breathed, over the years and decades it could give a potential dose of carcinogenic

hydrocarbon which was effective in susceptible people. An effective dose may take 30, 40 or 50 years to accumulate and that was the common cancer age. The primary effect of the soot was where it was deposited, on the skin, lungs or digestive tract, but, after absorption, the cancer-producing substances were distributed over the body and affected certain organs or tissues.

Observations on tar painting of 200 mice in 1924, and experiments up to the present had shown the great differences in individual susceptibility, latency, and the varieties of tumours which might be produced. It might well be asked, was there any other substance so widely distributed in such amounts, and with such cancer-producing properties as benzpyrene in the air?

With such facts before them it seemed an inevitable, logical and satisfying conclusion that most of the cancer in man and his longer lived domestic animals was due to the long continued exposure to smoke in atmospheric pollution. Satisfying, in the sense of indicting the Devil we knew, rather than some hypothetical substance it had not been possible to find, perhaps because it did not exist. The incidence of cancer amongst people (nation, city, town, family and person) was due to the actual dose received and that again to the degree and duration of their exposure, to their residence, occupation or habits, and to their personal susceptibility.

Much research had been carried out into the more intimate aspects, chemical, morphological or genetical, of the cancer cell itself. However interesting this might be, it seemed hardly likely to have any very direct bearing on prevention, diagnosis and treatment. It was obviously desirable to prevent but even if smoke could be abolished tomorrow, it was a melancholy fact that cancer would not disappear at once but gradually over a period of years.

In 1952 some 87,000 persons died of this disease and it must follow, therefore, that some hundreds of thousands of persons in their middle and later decades have already received an effective dose, which must eventually kill them.

These views, concerning the external cause of cancer—by cancer-producing substances discharged into the air and absorbed by the body—had long been held by him, continued Professor Pybus, but now the accumulated evidence of cancer in human beings and in the laboratory on experimental animals should be sufficiently obvious to effect their general acceptance.

It was therefore felt proper to bring these conclusions before the Society, in the hope that it might help their efforts, and as a tribute to their endeavours.

H. G. Ludgater (Solid Smokeless Fuels Federation) said he thought it was opportune to mention the West Riding domestic smoke campaign, which was sponsored by the Yorkshire Division of the Society and the West Riding Regional Smoke Abatement Committee, and organized by his Federation. Sir Hugh Beaver had mentioned publicity and public opinion, and they were attempting in this scheme—a pilot scheme—to sound public opinion and learn how best to put publicity across. This was being done by their mobile exhibition, by meetings, public and invited, by advertisements, and above all by the excellent co-operation of the Press.

Mr. Ludgater said he must sound a note of warning on the President's suggestion of £20,000 a year as the Society's expenditure. One could quite cheerfully get rid of that sum in a single campaign of the kind he had mentioned, although much could be done on a co-operative basis. He appealed to local authorities and regional committees in other areas, and particularly in the "black spots," as depicted by Sir Hugh Beaver, to consider similar campaigns, for which arrangements could be made.

At Glasgow last year his Federation had been allowed to present the case

as to the availability of smokless fuel. The facts and figures given in the paper had received considerable criticism, but the Federation had gone into the matter in considerable detail, and, strangely enough or otherwise, their figures were correct within a few thousand tons. In this opinion the time was opportune for action by local authorities, but they must not only be fully aware of the problem but must know the answers to the questions that they would be asked.

Miss Dorothy Boyd said that from her study of the Society's work and the deliberations of the various Commissions there emerged three grim facts:

1. That nowhere in the world was coal used as wastefully as in this country.
2. That half the smoke generated in this country came from the domestic consumer.
3. That unless their findings were put into operation, the work of the Committees, including the Beaver Committee, would remain of academic interest only.

Those facts, supported by what she had heard that day, strengthened her conviction of the need for a national campaign to inform public opinion that coal was their most vital raw material and not merely something to be burned.

It has been proposed that the Society should undertake the task. Being members of the Society, they all knew how small was its income and its staff and when they considered the brilliant work done by Mr. Marsh and his staff (so badly depleted by the tragic loss of Mr. Silver) in preparing the graphic and informative *Smokless Air*, submitting such a lucid 10,000 word memorandum to the present Committee, and dealing with the ever-increasing number of inquiries, then, indeed, they might congratulate them on their excellent work and themselves on having their erudition at their disposal.

What could they, as members, do to help? For, since they were all domestic consumers, they had a responsibility in the matter.

Miss Boyd went on to suggest that talks and small exhibitions with a few well contrasted photographs of atmospheric conditions and one or two graphic posters made a useful beginning.

Photographs of the stoves exhibited by the Solid Smokeless Fuels Federation at Charing Cross in January, with the amount of fuel consumed by each per week together with an estimate of the weekly cash saving in using the correct fuel, was a good follow-up, for cost was always a main consideration.

If some of the more spectacular by-products of coal were illustrated, for instance, tar needed for dressing road surfaces, plastics in the home and advanced surgery, aspirins and M. and B., and nylon in all its ramifications, then attention would be arrested and stimulated.

An informed public opinion would create a demand which would encourage and stimulate the production of smokeless fuels in the same way as public opinion and demand had been responsible for the present Committee, without which they would not have had the privilege of Sir Hugh Beaver's presence at, and his contribution to, the Conference.

Miss Boyd concluded by appealing to everyone present to assist in that work and so bring England's green and pleasant land into the very heart of their towns and cities.

Alderman G. H. Goulden (Salford) said he had no irons in any fire—he had just a human interest in the subject. He had had the pleasure of meeting Sir Hugh Beaver in his own city, and Sir Hugh had seen what they were trying—and he meant trying—to do, the success of which was very small compared with the efforts being made.

It was not a question of education alone. In that problem they had compulsion and co-operation, but compulsion was gaining ground. Any town or city that was attempting to

secure areas of clean air had first to get legal authority.

He did not believe in out-and-out compulsion, but there were times and issues on which the people must be told and not educated, as they had been doing at this and past conferences. As he had said before—co-operation as far as it went, and compulsion from then on.

Alderman Goulden pointed out that the Government wanted to build 300,000 houses a year, and for every year for a very long time. Every new house that went up could become a smoke emission plant. Unless Sir Hugh in his report suggested it, and the Government put it into operation, that it was a condition of loan sanction that only smokeless fuels should be burned in new houses—then all they would be doing would be to perpetuate smoke. The Government wanted them to knock down the slums, but as far as their fires were concerned the new houses would be as detrimental to health as the slums had been.

He asked the Government to give them, without having to go on their hands and knees to this interest or that householder, or that voter, the authority to say that if you went into a new house or a new factory it was a "must" that there should not be any plant that emitted smoke put into the building or the house.

G. H. Wilkinson (Corby) said that sulphur dioxide had not been mentioned in the papers, in spite of it being one of the most serious constituents of air pollution.

One lead peroxide gauge in Corby was placed on the outer edge of a pre-war estate in 1949. During the past five years some 1,000 houses had been erected in the immediate vicinity. The winter daily mean of SO_2 had progressively increased from 0.71 in 1949/50 to 1.52 in 1953/54. Mr. Wilkinson asked whether this increase would have been halted if solid smokeless fuels only had been used in the domestic grates. Any developments in the extraction of sulphur from solid smokeless fuels would be welcomed.

He was pleased to report that due to the efforts of his Council, and the co-operation of the local steel company, the annual monthly mean figure for a standard deposit gauge sited about half a mile from the centre of the steel works had decreased from 28.2 tons per square mile in 1949/50 to 25.7 tons per square mile in 1953/54.

E. W. Wignall (Secretary of the Coal Utilisation Council) said that his Council did not accept that domestic smoke was necessarily the most serious form of atmospheric pollution. The Council supported, however, its reduction; the most practical means of securing this was the increased use of solid smokeless fuels. In this respect, the increasing interest of the gas industry in producing coke suitably sized and graded for domestic use was most welcome.

Local authorities could encourage the use of coke by making better provision for fuel stores—on which subject the C.U.C. had recently issued a new publication.

Nottingham had shown that on a new housing estate, where modern appliances capable of burning solid smokeless fuels had been installed, a smokeless zone could be established fairly readily.

But what of the millions of houses which still had old-fashioned grates? The most useful contribution towards smoke abatement in those premises was the installation of modern solid fuel burning appliances, permitting the use of smokeless fuels. Many would still have to use coal for a long time to come, but the more efficiently this was burned, the less smoke would be produced.

Mr. F. J. Redstone (Bristol) moved a vote of thanks to Sir Hugh Beaver for being present at the Conference and for his encouraging address. The resolution was put to the meeting and carried with acclamation.

THE IMPACT OF RAIL TRANSPORT ON THE PROBLEM OF SMOKE ABATEMENT

by

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Introduction

THE British Transport Commission is keenly alive to the problem of air pollution and the control of the emission of smoke and evidence of this appears in the Interim Report of Sir Hugh Beaver's Committee. Evidence has also been given by representatives from the British Transport Commission in the House of Lords in connection with the Birmingham Corporation Bill and the Commission has been represented at meetings of local authorities to deal with smoke nuisance.

Air pollution consists not only of smoke but the harmful effects of sulphur dioxide to health, buildings, bridges and property in general. However, of the five million tons of sulphur dioxide which are discharged annually into the atmosphere by the burning of solid fuel, according to Sir Hugh Beaver's Interim Report, the Railways contribute .4 million tons or 8 per cent., whilst electricity works, industrial plants, household fires and other miscellaneous users of coal are responsible for the remaining 92 per cent.

"Elimination of smoke does not necessarily mean the attainment of fuel efficiency. In some conditions, smoke can be avoided by reducing boiler efficiency, for instance, by admitting additional air. However, the efficient use of fuel means its smokeless use." (*vide* Lord Ridley's Report).

This paper is mainly concerned with the coal consumed by locomotives on British Railways. The total allocation of coal to the British Transport Commission is fourteen million tons per annum; about thirteen million of this are consumed on locomotives. This represents approximately 6 per cent. of the total coal produced in this country. Of this amount, the majority is consumed when the locomotives are actually working and, under such conditions, there is comparatively little smoke emitted from their chimneys.

The principal cause for complaint arises from (*a*) Locomotive Depots, where there is a concentration of locomotives and which Depots are usually near cities and industrial centres, and (*b*) Locomotives in Traffic.

A. Locomotives on the Shed

(1) *Lighting up*

It is not possible to light up locomotives from a cold condition without the emission of a certain amount of smoke.

Locomotives are washed out on a laid-down basis and this means that after the boilers have been re-filled with cold water, on the fire being lighted, a certain amount of smoke is emitted. This, however, becomes less as the boiler becomes hot and when steam has been generated, the smoke can definitely be controlled by use of the jet or blower.

(2) *Disposal and Stabling on Shed*

Locomotives arriving on the Depot have their fires either completely removed or the fire is cleaned, i.e.,

the clinker is taken out and a small fire is maintained in the firebox to enable them to be kept in steam until they are due to return to traffic. If the time interval is extensive, the fires are completely removed and re-lighted in sufficient time to enable a proper head of steam to be raised before the locomotives are returned to traffic. This produces a consequent saving in fuel. There will always be, however, a certain number of locomotives either fresh fired or standing in steam, in the shed or on the departure roads, and where a heavy concentration of locomotives is concerned, in total there must be smoke arising from such a Depot.

A recent investigation has been made with the object of establishing the amount of smoke emitted in this manner and to obtain some information regarding the area of pollution.

The test was arranged to cover a radius of about ten miles from Charing Cross and, within this area, there are about 700-800 steam locomotives owned by the British Transport Commission and actual observations were made covering these. The results are shown below, from which it will be seen that less than 15 per cent. were emitting smoke which could be described as darker than grey haze. During the morning, the percentage was about 10 per cent. and the worst period occurred between 6 p.m. and 10 p.m., when the figure rose to almost 20 per cent. It will be noted that the area around the Motive Power Depots accounts for, roughly, 75 per cent. of the instances.

123 visits were made to Main Line termini and 275 locomotives observed and 60 visits were made to Motive Power Depots and 1,816 locomotives were observed.

Further, detailed surveys were made at two Motive Power Depots which showed the rates of deposition as under:

(*a*) *Distance from M.P. Depot*	*Deposit (tons/month)*
20 yds. (N.E.)	125
70 yds. (W.N.W.)	108
300 yds. (N.N.W.)	12
350 yds. (S.)	8.3
(*b*) *Depot itself*	59
80 yds. (leeward)	49
300 yds. (windward)	29
800 yds. (leeward)	9

(3) *Remedies*

Staff.—Every effort is being made to train the staff, both those employed at Motive Power Depots and footplate personnel. This will later be referred to in greater detail.

Disposal of Locomotives. — Shed Masters are being encouraged to consider very carefully locomotives arriving on the Depot and to have the fires completely removed where the period on the shed justifies such action.

The relations between the British Transport Commission, the Ministry of Fuel and Power and the National Coal Board are good, and having regard to the qualities and quantities of the fuel which is available, the

Average number of engines, and density of smoke emission, in the London Area

Location	Smoke Density 0	1	2	3	Total
Main line termini	25	18	4	—	47
All M.P. Depots	217	270	66	18	571
Other places (yards, other stations, sidings, etc.	76	46	13	—	135
Total	318	334	83	18	753

0=negligible. 2=medium opaque smoke.

1=light haze. 3=heavy black smoke.

Railways obtain their fair share of suitable fuel. These supplies have, however, to be augmented to some extent by qualities of fuel which would not be selected by choice and also a proportion of graded fuels have to be taken and, by mixing, can be made good use of in the locomotives.

The total quantity of fuel consumed by locomotives on British Railways is approximately 13 million tons per annum and, of this, almost one million tons consists of briquettes manufactured from small sized fuel, compressed into briquettes by the aid of a binding agent.

The shape and size of briquettes for firing locomotives is most important and work is in hand to produce a shape and size of briquette which will be satisfactory from the point of view of good combustion whilst, at the same time, mechanically it is of a shape which is reasonable to handle and can be retained in position on the locomotive tenders. At the present time, there are about fourteen different types of briquettes which, whilst suitable for industrial and other purposes, are being diverted to the railways for use in locomotive fireboxes and some of these are not entirely satisfactory.

Research is also taking place regarding the use of a binding agent which, it it hoped, will avoid certain objections to the use of briquettes as these, in their present form, produce a good deal of dust which is objectionable to the enginemen and, in some cases, has caused skin irritation. The present binding agent, i.e., pitch, also is inclined to make more smoke than is the case with Large Coal.

The use of coke has been the subject of further modern experiments and, whilst in certain specialized and local conditions, it might be possible to use a very limited quantity, it is not suitable for ordinary working. Greater space is required on the tenders or bunkers of the locomotives, necessitating more frequent visits to the Motive Power Depots for re-fuelling. It is considered that a better alternative to the use of coke would be by diesel locomotive, about which more will be said.

Some of you may remember that at one time oil was burned in conjunction with coal to a limited extent and, under these conditions, it was introduced through the firehole door. This arrangement was introduced at the time as it was an economical one but it was eventually discontinued due to increase in the cost of oil.

Fuel oil can be burned satisfactorily, however, in the locomotive type boiler but it requires modification to the inside of the firebox, with special fittings including a pre-heating coil.

It will be remembered that, a few years ago, a more extensive scheme was considered for the burning of oil in locomotives to save one million tons of coal per annum on British Railways' locomotives but, due to an alteration in the world oil markets, the scheme was abandoned.

The burning of oil in a locomotive type boiler is usually accompanied by the emission of more smoke than normally would be the case when using coal as fuel.

(3) *Training of Staff*

It will be appreciated that the training of staff, with particular reference to the efficient use of coal, is part of the policy for training both Drivers and Fireman and a subject to which the British Transport Commission has given a good deal of thought.

New Entrants to the Railway Service in the Footplate Grades

New entrants into the Railway service commence as Cleaners and are given preliminary tuition in a number of subjects which they require to know as Railway servants, i.e., with regard to their personal safety in moving about among locomotives and trains, both in the Motive Power Yards and on the Main Line, but so far as this paper is concerned, it is mainly in their training to act as Firemen with which we are concerned.

The training is arranged on a Depot or District basis with small groups of Cleaners, say up to twelve, and they are instructed by a Chargeman Cleaner and/or a Firing Instructor in the details

of locomotives, i.e., the parts and functions of the fittings of locomotives and the lighting up and maintaining of fires in locomotives on the Depot, and their general duties and responsibilities as a Fireman.

Before a Cleaner is allowed to act as a Fireman, he is given a period of two weeks' preliminary tuition by the Firing Instructor, which includes practical instruction and demonstration in the duties which will be required of him as a Fireman. When a satisfactory report is received from the Firing Instructor, the Cleaner is given an oral examination by the Locomotive Shed Master on subjects of which he is expected by that time to have knowledge and these include the method of firing a locomotive and the general duties and responsibilities of a Fireman. If the examination proves satisfactory, a Firing Certificate is issued by the District Motive Power Superintendent and the Cleaner is redesignated "Passed Cleaner," meaning that he can be utilized as required on Fireman's duties. Obviously, he is not fitted at that stage to take his place on the Main Line but there is an agreed system which enables him to be used as a Fireman when necessary, commencing with shunting locomotives and gradually increasing the importance of the work as experience is gained. As soon as possible after the Passed Cleaner has commenced to work as a Fireman, the Firing Instructor rides with him to give further instruction in the proper firing methods, economy in coal consumption and, if possible, he will travel with each Passed Cleaner on the first occasion that he acts as a Fireman on the Main Line. A report is submitted by the Firing Instructor indicating the result of this further examination.

Smoke Extraction from Shed.—Considerable research and development has taken place regarding the design of Motive Power shed roofs, but more from the point of view of getting the smoke out of the shed.

British Railways are now considering the means to be taken to disperse the smoke outside the shed.

At one new Depot to be erected, it is proposed to provide a brick chimney, about 200 feet high, to draw the smoke from the ducts in the shed and disperse it at a high altitude. This will not reduce the volume of smoke, but release it at a level where it is less offensive than in concentrated form at low level.

Pre-steaming of Locomotives.—This is a practice in use in America and Canada, but about which there is no actual experience in Britain. It consists of supplying steam from a stationary boiler and introducing it into the locomotive boiler, first to heat up the cold water, then to give an initial head of steam, say, 100 lbs. per sq. in. After this, the locomotive is fired in the ordinary way and smoke is reduced because the boiler is hot and its emission can be controlled by the use of the blower or jet.

In America, it is usual to have a fairly large stationary boiler to give a steam supply, say, 80,000 lbs. per hour, for many purposes, e.g., Station, Motive Power Depot, Carriage Sidings etc. These are usually mechanically fired with chain stoker grates and burn a low grade fuel.

In addition to reducing smoke, it is claimed that there is economy due to burning low grade fuel efficiently in the stationary boiler, compared with raw large coal in the locomotive grates.

In this country, the conditions are quite different but it has been agreed to try such a scheme at one Motive Power Depot to establish facts and provide data. To reduce the cost, the scheme has been combined with one for the washing-out of locomotive boilers by using hot water and the required stationary boilers will, therefore, provide steam for the dual purposes.

B. Locomotives in Traffic

(1) *Working Conditions*

When a locomotive has left the Motive Power Depot and is handed over to the Traffic Department for working purposes, the footplate staff, i.e., the Driver and Fireman, are entirely responsible for its good work-

ing and management. These men, therefore, work without any direct supervision and it is apparent that the training of Firemen is of great importance.

It would, however, at this stage, be convenient to draw attention to the detailed fittings of a locomotive boiler showing the arrangement for controlling the primary air supply, the secondary air supply and the means by which the blast is produced for causing conditions suitable for rapid combustion on the grate. The jet, or blower, operates in the smokebox.

From Fig. 1, it will be seen that underneath the fire-grate is arranged an ashpan, having dampers which control the admission of the primary air to the underside of the firebars. To promote complete combustion, it is essential that secondary air should be admitted to burn completely the CO to CO_2 and also to satisfactorily burn the smoke or unconsumed particles of carbon. To assist in this, a brick-arch is arranged which deflects the products of combustion towards the firehole door through which the secondary air is admitted. This can be controlled and is, in turn, deflected by means of a baffle plate fixed inside the firehole, which assists in the complete mixing with the secondary air and effects proper burning before the products of combustion are drawn away through the tubes to the smokebox. All modern locomotives are provided with a superheater and the gases are therefore drawn through the small boiler tubes and also the large smoke tubes into the smokebox. The exhaust from the cylinders provides the necessary blast for effecting combustion and the exhaust steam, together with the products of combustion, are ejected from the chimney. When the locomotive is not working but is in steam, a blower, consisting of a ring of steam jets, is arranged either around the blastpipe or the base of the chimney, which causes a powerful induced draught and, by suitable control of air through the firehole door, it is possible to avoid making smoke.

A small quantity of smoke should be emitted when the locomotive is working; in fact, the complete absence of smoke indicates a surplus of secondary air, which is uneconomical.

A number of experimental devices have been tried from time to time in this and other countries to reduce the emission of smoke, but the additional complications and maintenance difficulties have more than outweighed the advantages to be obtained. The author refers to such appliances as the one which provides a jet of steam to be blown through certain of the tubes. Another device used in America in connection with the burning of small coal consists of ferrules fitted through the lower part of the water space of the firebox just above the fire bed and through which jets of steam are introduced with the object of providing additional secondary air which, mixing with the gases, promotes complete combustion.

(2) *Fuel*

The type of fuel for which locomotives in this country have been designed is that known in the coal industry as Large Coal. It is well-known that Large Coal as such is not produced in the same quantity as was the case in past years and that the quantity mined is becoming gradually less. Further, the quality of the coal is not being maintained due to many of our first-class seams becoming exhausted. It therefore follows that different grades and qualities of fuel are being used today from those which were available, say, before the war.

Following the war period, there was a reduction in the working hours of Railway personnel from 48 to 44 hours per week. During this transition period, rapid promotion occurred to certain Railway staff and to provide Firemen, it was necessary to recruit additional Cleaners and these men, with very little training, were passed out on to the footplate to act as Firemen. During this period, it will be apparent that the normal training could not be given and, as a result, a number of the junior Firemen—for a time, at any rate—had

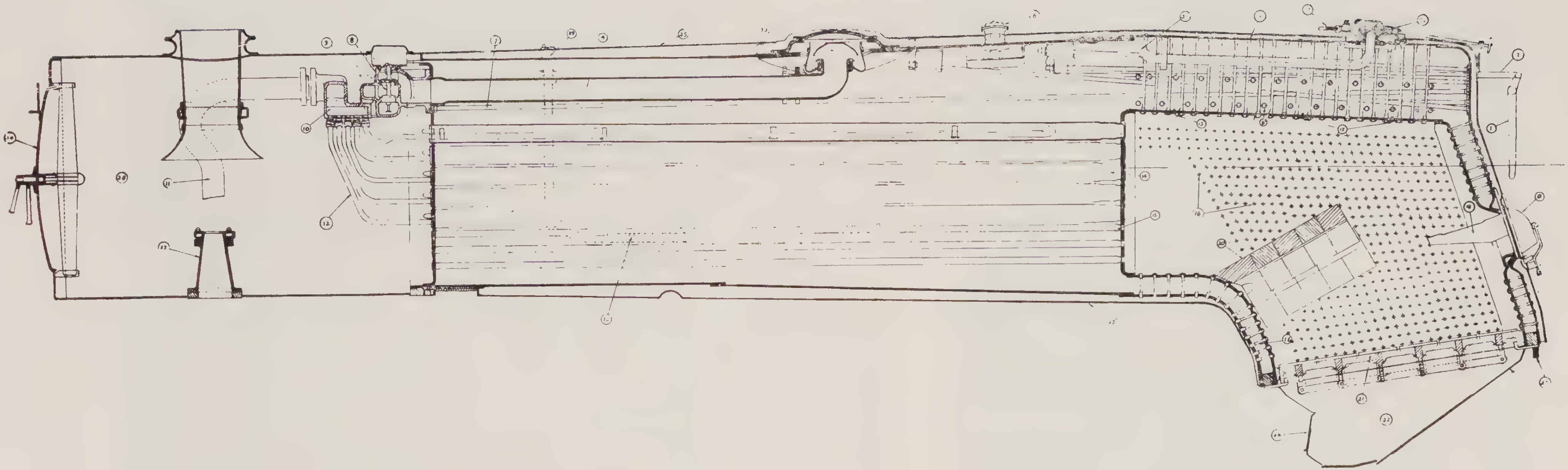

Fig. 1

not received the required training. The position at present, however, is more normal and the ordinary rate of promotion which permits the training referred to previously has now been restored.

With regard to subsequent promotion; a very careful examination is made by the Locomotive Inspector on the occasions when a Fireman is passed to act as a Driver. This is, naturally, a much more detailed examination but, among other things, the prospective Driver has to satisfy the Inspector on his knowledge, care and manipulation of the locomotive and he is also subjected to a practical test, both on freight and passenger working. Again, a Certificate is issued, signed by the Inspector and the District Motive Power Superintendent, if the applicant successfully passes the examination, after which he can be used as a Driver.

Mutual Improvement Classes

Mutual Improvement Classes are held throughout British Railways and there are over three hundred separate classes in existence. These classes are run by the men but every assistance is given by the Management, including the provision of accommodation, in many cases the provision of an Instructor and the use of models and diagrams. The classes function on an entirely voluntary basis and are most keenly attended by the men of the Depots.

Lectures are given and discussions on locomotive matters are held. In addition to the recognized class lecturers, the District Motive Power Superintendent and other Officers give the lectures, at which special attention is given to the preparation of Cleaners who are about to be examined as Firemen and Firemen who are required to pass the qualifying examination as Drivers.

Many subjects, both on mechanical details and all matters of Motive Power and Operating interest are discussed.

Each year, a competition is run by the British Transport Commission and classes are invited to take part in the contest, which takes the form of a "quiz" programme. A very high standard of proficiency is attained by the team members and knowledge of combustion is a predominant feature of the various questions put to the team. Prizes are given for the winning teams and the final team is usually awarded a trip to the Continent, which includes visits to Motive Power Depots and other items of particular interest to locomotivemen.

Instruction Trains

Some of you may have had an opportunity of inspecting one of these trains on the occasion of the Annual Conference at Margate in 1950.

The trains, as shown in the illustrations, consist of two coaches (see Figs. 2, 3 and 4). In one coach, an oil-fired boiler produces steam, which is applied to various boiler fittings for

Fig. 2

Fig. 3

Fig. 4

instructional purposes as well as heating the Instruction Train. By referring to Fig. 3, it will be noted that at the far end of the coach there is a reproduction of the firebox end of a locomotive boiler, complete with firehole door and all the steam fittings, which fittings are actually live, having steam supplied to them from the oil-fired boiler. Here, again, the proper methods of obtaining efficient combustion are emphasized. Sectional models of various locomotive fittings are provided, together with models of valve gear and diagrams of all descriptions.

The second coach is a lecture room (see Fig. 4), with a cine-sound projector and epidiascope, and a number of films have been made by the Railways demonstrating efficient locomotive working. Some of these films, again, have particular reference to complete and satisfactory combustion and the working of locomotives. These are sound films which show actual performance in traffic and are provided with a running commentary describing the proper method of firing and how to obtain the best results. One of these films, "Little and Often" was exhibited at Margate in 1950 and many of you had the opportunity of seeing this film, which describes in detail the method of firing, with actual "shots" from the footplate.

A further film is available and can be seen today after this meeting. The film, known as "Wash and Brush Up," describes fully the servicing arrangements from the time a locomotive is withdrawn from traffic and put on the Motive Power Depot until its return to traffic. During this time, the fire is removed from the grate, the ashpan and smokebox are cleaned, the tubes and firebox are thoroughly cleaned, the boiler is emptied and washed out to remove sludge and scale, and the whole process to maintain the locomotive as a free steaming unit capable of effecting good combustion is fully described.

Alternative Forms of Motive Power

The British Railways are considering

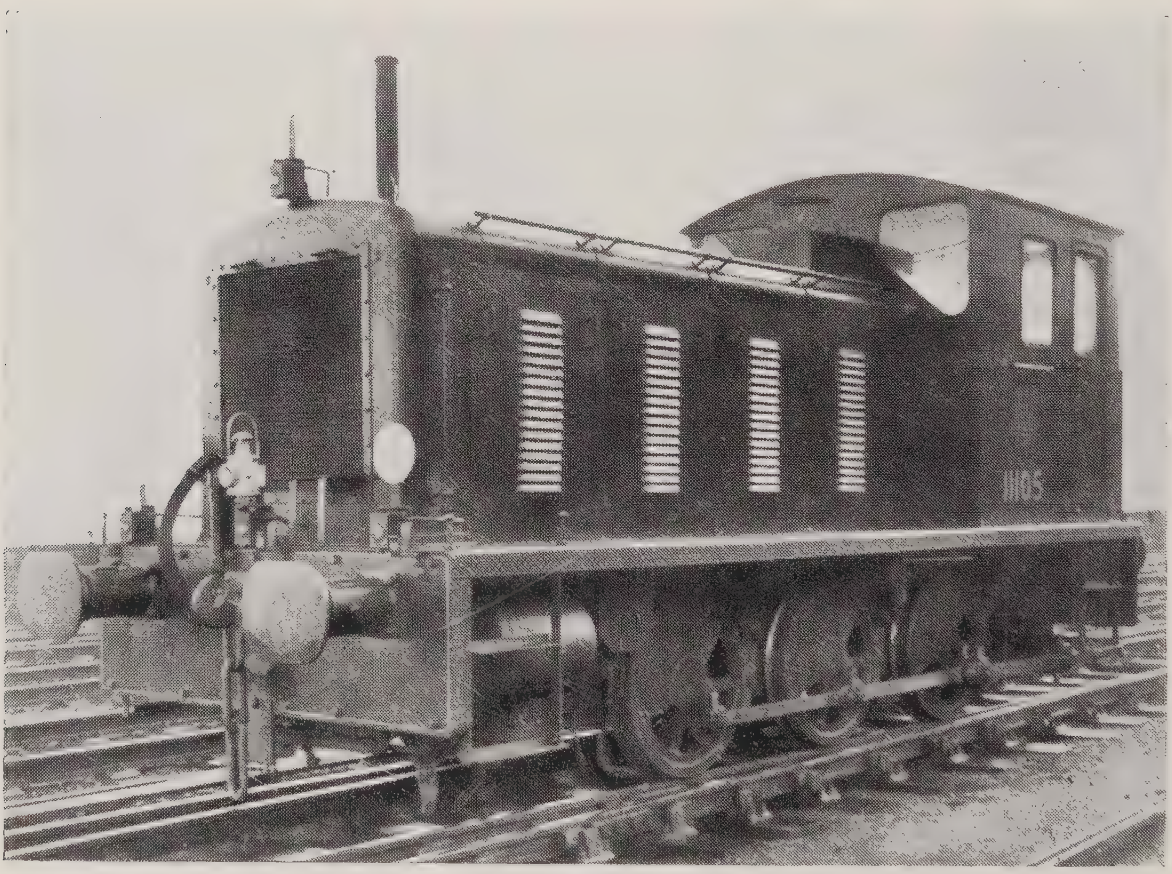

Fig. 5

alternative forms of Motive Power to the coal burning steam locomotive. Electrification has been introduced in some parts of the country and it may well be that an extension of electrification, either Main Line and/or of a local character, will develop. In addition, alternative forms of locomotives are being developed and the following are examples of diesel mechanical locomotives, diesel electric, diesel hydraulic and gas turbine locomotives, and multiple unit rail cars.

Fig. 5.—British Railways have a number of 153 h.p. and 204 h.p. diesel mechanical and diesel hydraulic locomotives of this type for shunting work, where sharp curves are encountered. The one shown is of the 204 h.p. group and has a tractive effort at low speed of 16,850 lbs.

Total weight is 29 to 30 tons and maximum speed, about 25 m.p.h.

Fig. 6.—This shows a standard diesel electric shunting locomotive of 350 h.p. and is one of which several hundred are being built.

Total weight is 50 tons and tractive effort—34,944 lbs., while maximum speed is 20 m.p.h.

Fuel capacity is 660 gallons and these locomotives remain in traffic away from the Motive Power Depot for a fortnight.

Fig. 7.—This shows the 827 h.p. Mixed Traffic diesel electric locomotive.

This was designed for branch line services of both passenger and freight working and is also capable of specially controlled speeds for hump shunting purposes.

Weight in running order—69 tons 16 cwt. and maximum speed 70 m.p.h.

Fig. 8.—This shows the first Main Line diesel electric locomotive put into service in Britain which, together with No. 10,001, worked the Anglo-Scottish services of the former L.M.S.R. between Euston and Glasgow.

Powered by a 16 cylinder "V" type diesel engine, they develop 1600 h.p. and have a maximum tractive effort of 41,400 lbs. and are capable of a maximum speed of over 90 m.p.h.

Fig. 9.—This shows a diesel mechanical Main Line locomotive of 2,000 h.p. In this locomotive, there are four main engines, each of 500 h.p., supplying power to a common gearbox for traction purposes. Two independent diesel engines supply power for the auxiliary services.

The locomotive weighs 120 tons, has a maximum tractive effort of 25,000 lbs., and is capable of a maximum speed of 78 m.p.h.

Fig. 6

Fig. 7

Fig. 8

Fig. 9

Fig. 10.—This is the first gas turbine locomotive to operate in this country. It is of 2,500 h.p., weighs 115 tons, has a tractive effort of 31,500 lbs. and is capable of a maximum speed of 90 m.p.h.

It is operated by heavy fuel oil driving a gas turbine, which, in turn, drives an electric generator and the final drive is by electric traction motors on the bogies.

Fig. 11.—This is a later type of gas turbine electric locomotive of over 3,000 h.p., capable of a maximum speed of 90 m.p.h. Total weight is 129 tons 19 cwts. and maximum tractive effort 60,000 lbs.

As originally built, this locomotive was run on gas oil but consideration is being given to converting it to heavy fuel oil.

Fig. 12.—The diesel electric locomotive 10203 is the latest to be built by British Railways and is of 2,000 h.p. It is capable of a maximum speed of 90 m.p.h. and weighs 132.8 tons. It has a maximum tractive effort of 50,000 lbs.

Fig. 13.—This shows a pair of diesel rail cars. These are powered by two "flat" diesel engines of 125 h.p. Each engine drives on one pair of wheels of the bogie, giving a total of 250 h.p. per car.

They can be used in conjunction with trailer cars and marshalled as trains up to six or eight cars, being driven from one master controller. The trains are operated by a Driver and Guard, no Fireman being employed.

The first group of these rail cars are operating in the West Riding of Yorkshire and six other schemes have been authorised. These schemes displace 57 steam locomotives.

Policy of British Railways with regard to Traction

Electrification

It can be stated that the British Transport Commission are giving consideration to schemes for the electrification of certain sections of the Railway but, at the present time, no public announcement of these projects can be made.

The most important recent developments in this connection are the electrification of the Liverpool Street-Shenfield section for passenger working by multiple unit electric stock and the more recent electrification of the

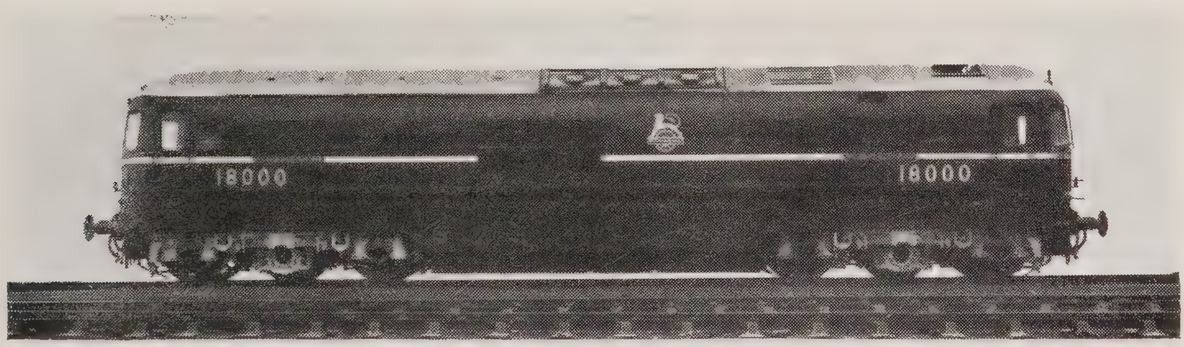

Fig. 10

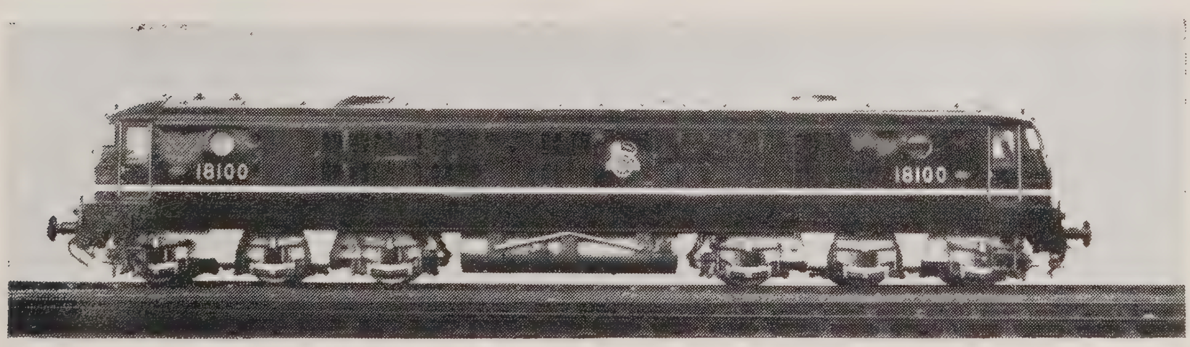

Fig. 11

Manchester - Sheffield - Wath Main Line, which scheme has not yet been completed. This includes the first real Main Line freight electrification in the country, the trains being hauled by electric Mixed Traffic locomotives. There are 58 of these Mixed Traffic locomotives, used mainly in connection with the main mineral traffic passing from east to west over the Pennines but, in addition, the scheme will ultimately necessitate the use of seven electric passenger locomotives and eight sets of multiple unit electric passenger coaches.

Diesel Locomotives

There are, at the present time, approximately 270 diesel shunting locomotives and a Replacement Programme, spread over five years, is being completed which provides for an addition of 573 diesel shunting locomotives in replacement of 635 steam shunting locomotives. This programme

Fig. 12

Fig. 13

should be completed by the end of 1957, when there would be approximately 800 diesel shunting locomotives working on British Railways. This represents 30 per cent. of the total number of shunting locomotives in Britain and about 460 of these will be operating in the "black" areas. This programme does not represent completion of the substitution of diesel shunting locomotives for steam locomotives and a further programme is under consideration at the present time.

In considering the substitution of diesel for steam traction, it should be borne in mind that the average availability for steam locomotives in this country is approximately 84 per cent. and that of steam shunting locomotives is over 90 per cent.

Consideration is also being given to developing a general purposes diesel locomotive of 1,000-1,200 h.p., with the object of dealing with both passenger and freight services on branch and feeder lines.

Diesel Rail Cars

Reference has already been made to the fact that seven schemes have been approved by the British Transport Commission, which provide for 107 motor cars and 63 trailers in substitution for 57 steam locomotives.

In replacing certain services with diesel rail cars, opportunity has been taken to improve the timings and, in most cases, to improve the services so that the mileage to be run by the diesel rail cars is considerably higher than the steam mileage which is withdrawn.

It is the policy of the British Transport Commission to develop this form of traction where it is suitable and a number of further schemes are receiving consideration.

Gas Turbine Locomotives

There are two experimental oil gas turbine locomotives with final electric drive operating on British Railways (see Figs. 10 and 11). A further experimental gas turbine locomotive, with mechanical transmission, is under construction. This project is joint between British Railways and outside industry and, in this case, the fuel will be pulverized coal. It is hoped this locomotive will be placed in service for experimental purposes in 1955 or 1956.

Conclusion

In conclusion, the Author would like to express his thanks to the British Transport Commission for the facilities provided to enable him to produce this paper and to make use of the information presented therein.

Discussion

Councillor Dr. H. K. Ashworth (St. Marylebone) said that the steps outlined by Mr. Harvey to lessen atmospheric pollution by steam powered locomotives did not seem to go far enough or fast enough for those who dwell in St. Marylebone or the neighbouring Borough of St. Pancras and Hampstead. These Boroughs were subject to appalling atmospheric pollution because of the emergence from long tunnels (or other vents) of smoke from heavy trains being hauled up-hill from the mainline termini with their engines steaming flat out. Why could not British Railways copy the American example of prohibiting steam powered locomotives from entering London, either by increased use of electrification or Diesel engines? The only proper place for a steam-powered locomotive in North London should be in a museum.

Dr. A. Parker (Fuel Research Station) said he was only going to ask one or two questions on the paper, which he had read with very great interest. As he understood it many years ago, maybe 70 or 80 years ago, it was the practice to use coke as the fuel for lighting up steam locomotive boilers

and then to change over to coal when the temperature had been raised, so that there was less risk of emission of really black smoke. Could Mr. Harvey tell him why that practice has been given up and changed over to lighting up from cold using coal? The other question was how far the number of times of lighting up from really cold could be reduced by better treatment of the boiler feed water, thereby reducing the number of times that it was necessary to wash out the boiler and fill up with cold water?

James Law (Sheffield) stated that Mr. Harvey should be complimented on his paper which showed with a wealth of detail how Deisel operated and electrically operated locomotives were being developed on British Railways.

Four years ago at the Margate conference, where a discussion on locomotive smoke took place, little or no hope was given that there would be any great changes in motive power for some years to come, but this paper showed that considerable progress had been made. It was stated that experiments in pre-steaming would be carried out and, though Mr. Harvey again stated that experimental work was being considered, it appeared that some effort to reduce pollution at locomotive sheds was long overdue and that British Railways had had ample time to put such work into operation.

The pollution figures given in the paper, where a deposit of 125 tons per square mile per month took place at a distance of 20 yards to the N.E. of the depot, was most illuminating and definitely showed how serious such pollution could be. It was considered that a pollution figure of 40 tons per square mile per month was the usual deposit in a heavily industrialized area, and a pollution figure of three times that magnitude was deplorable. It could be stated that there was scarcely a town or village in the whole of Great Britain that was not affected by railway smoke, and the national survey carried out by the Society some years ago had emphasized the fact.

Most of the delegates attending the conference used the London terminal stations and comparisons were most striking, Euston, St. Pancras, King's Cross and Marylebone being particularly bad.

Was there any scheme going forward in order to improve the atmospheric conditions at those stations or would they remain as they had done for many generations?

Councillor W. A. N. Jones (Birmingham) said the outcome of British Railways' work was fuel efficiency, but he did not think they were seriously or wholeheartedly concerned in this matter.

Referring to the training of firemen he said they were having to bring on to the footplate young men of 16, which was too young and was bad practice.

They were irresponsible and had to rely on instructions from the driver as to how to use the fuel to the best possible advantage. Drivers did not like to have to take their eyes off the signals and controls to do that.

From a practical man's point of view, the great liaison that had been hoped for from the National Coal Board and British Railways was lacking and there were instances when the railways got the poorest possible types of coal.

He supported the idea of pre-steam heating of engines before being put into service at depots in order to reduce smoke, because the pollution was something to be seen to be believed: even in modern depots the sulphurous fumes that hung a few feet above the ground were damnable, causing the men to cough and spit and even leave the job.

P. H. Saunders (West Lancashire and Cheshire Regional Smoke Abatement Committee) said that as a former Locomotive Engineer and now Smoke Abatement Officer for Liverpool he had followed Mr. Harvey's paper with

considerable interest, and had to admit that the problem of railway smoke prevention was shown in an entirely different light from that under which he had regarded it when he was on the railway. His short experience of firing a locomotive was as an apprentice engineer, and had he known then as much about the combustion of coal in a locomotive firebox as he did today, his work on the footplate would not have been the ordeal of toil and sweat which he had made of it.

Mr. Harvey had explained what the railways were doing so far as smoke from locomotives was concerned, but a great deal of pollution was caused by the burning of that one million of the fourteen million tons of coal mentioned by the Author; in their yard cranes, depot heating stoves and station fires, merely because coal was used for locomotives. If British Railways would use coke only on those cranes and stoves and fires they would make a great contribution to smoke abatement, and it would certainly not be a difficult thing to do.

Regarding the type of coal used on locomotives, Mr. Saunders could not understand why large coal was used; the fireman had to break it up into suitably sized pieces, and was invariably left with a large quantity of slack and small coal which had to be fired and which, incidentally, caused most of the grit nuisance. One would have thought it would have been more economical, if they could not obtain graded fuel, to install crushing and screening plants at the coaling depots and supply their engines with graded 3 in. and 4 in. nuts and to process the screenings into suitably sized briquettes.

Still on the question of fuels, Mr. Harvey had said that usually oil-fired locomotives created more smoke than when they were burning coal. Surely that was only in those cases where boilers designed for coal burning had been converted to oil-firing without alteration of the design of the firebox. There did not appear to be any reason why a boiler properly designed for oil burning should not give a much higher thermal efficiency and be practically smokeless.

So far as training of firemen was concerned, Mr. Saunders could from his own experience support the author's remarks, and repeated what he had said at Margate three or four years ago, that as far back as 1923 or 1924 the old Great Northern Railway used camera pictures of the actual firing movements to seek the best and most efficient method of training.

Mr. Saunders said he had found the ex-locomotive fireman working on industrial boilers the best type for applying science to the job, but he felt certain that the trouble today was not lack of training, but was the same as throughout a good deal of industrial boiler operation, the human element.

He also said that in his experience in Liverpool, the British Railways Executives had shown the greatest co-operation and he sincerely hoped they would, as soon as possible, extend to Merseyside some of those measures outlined in the paper for reducing low-level smoke from engine sheds and that they would be fortunate in securing still more Diesel locomotives for shunting.

He asked Mr. Harvey if the modern type of boiler as shown in Fig. 1, with the forwarded extended firebox, had shown any improvement in fuel-saving compared with the earlier square box-shaped type, and said he imagined the additional combustion chamber volume would give much better combustion, particularly of the higher volatile coals. He also asked what had happened to the water-tube boiler designed for locomotives by Sir Nigel Gresley about 1930, as he was under the impression that that type was a great step forward in locomotive boiler design.

Finally, he said, the author had referred to a pulverized coal gas-turbine-driven engine now being constructed. Mr. Saunders remembered seeing a pulverized coal-fired steam locomotive in Germany some years

ago, and understood there were a number at that time in America. Would Mr. Harvey say what possibilities there were in that form of steam generation as apart from fuel for gas turbines or locomotives with a view to using inferior grade fuels efficiently and smokelessly.

G. W. Farquharson (Birmingham) stated that Mr. Harvey had given the conference an excellent and splendid résumé of the alternative forms of motive power being developed and considered by British Railways, and the intended progressive replacement of Diesel for steam traction, especially in relation to shunting operations. That appeared to be the most progressive step in the reduction of atmospheric pollution from railways. He hoped the programme would be accelerated; it could and should be if the British Transport Commission was keenly interested in the problem of air pollution.

Mr. Farquharson then made reference to the Interim Report of the Air Pollution Committee and pointed out to Mr. Harvey that the table he had quoted in his paper also indicated that, when considered on a ton per ton basis, the pollution by smoke and grit from railways was greater than from industrial and domestic sources, and could Mr. Harvey account for that?

Mr. Farquharson also stated that if the British Transport Commission was so desirous of smoke abatement, why was it that on the promotion of Private Acts by Local Authorities in regards to smokeless zones they did their best, with great success, to ensure that railway engines would be exempt from such legislation?

The conference knew that atmospheric pollution by smoke could be controlled by smokeless zones and, whilst British Bailways were exempt, many areas where improvements could be effected would be restricted by the British Transport Commission's outlook.

On the training of firemen, Mr. Farquharson pointed out that it appeared to be hurried and insufficient. Training of locomotive firemen on engines engaged in shunting operations meant that the occupiers of houses bordering the sidings could give up all hope, because as soon as the "cleaner" was promoted to other line firing a fresh batch of "learners" would arrive.

A. H. Basford (West Hartlepool) asked whether the British Transport Commission had a scheme for the systematic rebuilding or modernization of existing engine sheds and if such a scheme would be completed in the foreseeable future.

He described the smoke nuisance which occurred at West Hartlepool where the engine sheds adjoined a large residential area. The flue ducts in the sheds were very short, some of them being lower than ridge height of the roof through which they passed. Smoke and condensate from the sheds and from engines being lighted up in the open air were dispersed at a low level towards nearby dwellings.

If the British Transport Commission was unable to embark upon large-scale improvements on the lines indicated by Mr. Harvey, some early modification should be made to the flue ducts of existing sheds so that smoke could be discharged to the atmosphere at a higher level than at present.

F. J. Redstone (Bristol) said he felt Mr. Harvey had very fairly stated the present position in regard to the action now being taken to deal with atmospheric pollution nuisance from the railways.

There was no reason, however, why the meeting should pull its punches in the discussion, as in many areas this form of pollution was a serious problem.

In his view the explanations made in the paper were an acknowledgment that something more must be done and the references to pre-steaming of boilers, chimneys to draw smoke from engine sheds, electrification and oil-firing in substitution for solid fuel

revealed that a great deal of attention was being given to that important matter.

Mr. Harvey had referred to "low grade firing work" and perhaps in reply he would enlarge a little upon that term. Did that mean that beginner firemen were often trained in the thickly populated areas and on shunting, etc.?

It had been said that "A man is only ready for life at the end of it." Could it be inferred from Mr. Harvey's remarks that a large percentage of firing training was carried out in areas where pollution would be most damaging, and if this was so, by adjusting the size of tenders, could coke be more intensively used as a fuel in such cases?

G. Nonhebel, in a contribution received after the conference, wrote that the measurement only of solids collected in atmospheric deposit gauges around motive power depots gave insufficient information and might blind the railway authorities to the seriousness of the problem. Although the grit collected was a nuisance, the major effect on the health of nearby residents was caused by the tarry smoke from the engines. This drifted long distances. Only a small proportion of the weight of solids collected by the deposit gauges came from this smoke. The measurement that would more clearly show the extent of the trouble was the Standard Suspended Smoke Measurement used by the D.S.I.R. Readings of that should, however, not be averaged over the 24 hours but be taken during the periods of high smoke emission from the depots. He hoped that British Railways and Local Authorities would make some of the measurements in areas of complaint. Study of them should help the Shed Masters to devise methods of reducing the worst conditions.

Mr. Harvey, replying to the discussion, said that Dr. Ashworth had referred to the delay in carrying out electrification schemes. A tremendous capital sum was involved and to give effect to even the Main Lines would run, probably, into some hundreds of millions of pounds.

With regard to the complaint of steam locomotives leaving the north London terminal stations, Mr. Harvey said that it should be borne in mind that when leaving Euston, King's Cross or Marylebone, a locomotive was faced with a fairly severe uphill gradient of about 1 in 70 and, after emerging from the tunnels, the locomotive fires were just beginning to be burned through. The emission of some smoke and grit was, therefore, unavoidable.

Dr. Parker had referred to the use of coke for lighting up. The main difficulty in using coke specially for lighting up was due to the fact that most of their larger motive power depots had mechanical coaling plants and it was impossible to arrange for coke to be put on the tenders or bunkers in the position suitable for lighting up. Further, it would be necessary to fill up the tenders or bunkers when the locomotives were leaving the depot and this would be a movement in the wrong sequence and cause congestion and expense. It was not a practicable suggestion, quite apart from one of expense of carrying coke to the locomotives in the shed for lighting up purposes.

A further question related to the possibility of reducing the number of occasions when locomotives were lit up from cold consequent upon the application of the boiler water treatment. The Commission had taken advantage of the possibility of extending the periods between washing out due to water treatment, and locomotives, some of which ran three days at one time, were now running 28-32 days or for even longer periods.

Mr. Law referred to a change in types of motive power and the delay in the provision of the pre-steaming plant.

Mr. Harvey said that there had not been a change of mind in regard to types of alternative forms of motive

power; development, however, had occurred which accounted for the present outlook on policy.

With regard to the delay in providing the pre-steaming plant to which some reference was made at the Margate Conference; this was the first plant of its kind in this country and the question of cost and justification required careful consideration. It was now being provided in conjunction with a hot water boiler-washing scheme. The material had been ordered and the work would proceed as soon as possible.

The Manchester - Sheffield - Wath electrification scheme was a part of the long-term policy of the Commission and did effect a very considerable saving in large coal and enabled a much smaller quantity of coal of an inferior class to be utilized in the power stations.

Councillor W. A. Jones referred to the policy regarding electrification, the training of staff and to mechanical coaling plants.

Mr. Harvey said that he thought it could be said that the long-term policy of the British Transport Commission was the electrification, at least, of the Main Line railways.

As he had mentioned early in the paper, the British Transport Commission were very keenly alive to the subject of fuel efficiency which was closely related to that of avoiding the emission of smoke. A Fuel Efficiency Committee was in operation, with representatives at varying levels who dealt with not only fuel efficiency as affecting locomotives, but offices, works, signal-boxes, etc.

With regard to the training of staff; there was a period following the war when, due to the rapid promotion of footplate staff owing to the reduction in working hours, it became necessary to utilize youths of 16½ as a temporary arrangement for firing purposes. The normal age limit was 18 and was in accordance with the Commission's promotional scheme for footplate staff, and it was hoped that the normal conditions would soon be in operation.

The circumstances under which, from time to time, mechanical coaling plants discharge a considerable quantity of small coal were well known to the Railway Authorities, but many of the later plants had been designed with the angle of the bunker in such a manner that small coal did not accumulate. The actual coal consumption measured in lbs. per mile showed a small but steady reduction.

In regard to pollution of the air in and around the depots, it was claimed in America that pre-steaming reduced the volume of smoke, and it was hoped that the experimental scheme to be introduced at Colwick would give promising results in this country.

Mr. P. H. Saunders, Smoke Abatement Officer, referred to the one million tons of coal used other than on locomotives.

Mr. Harvey said that this was consumed in the various works, offices, stations, signal-boxes, etc.

A Fuel Efficiency Committee, representative of all departments, was in being and dealt with the efficient use of fuels other than locomotive. This committee dealt with the use of efficient and modern heating boilers and the provision of modern grates in substitution for the ordinary open type. As an indication of their activities during the year 1952, the latest full year's figures available—modern appliances were installed in 950 stations and 3,744 houses owned by the Commission.

With regard to the quality of fuel used on locomotives, Mr. Harvey said that recent tests on the Locomotive Testing Plant at Rugby had indicated that certain graded fuels used in isolation were not suitable for locomotive purposes, but to further develop the use of such fuels, it had been agreed to loan a locomotive boiler to the British Coal Utilization Research Association, Leatherhead. Further tests would be continued by this Association with the object of developing a type of grate and ashpan arrange-

ment suitable for small type fuel. A modern locomotive boiler consuming the fuel for which it was designed was a highly effective producer. The boiler efficiency of many hundreds of locomotives in this country is well over 80 per cent.

The combustion chamber to which Mr. Saunders referred was definitely an improvement upon locomotives provided with a straight tube-plate in the firebox.

The water tube boiler referred to was designed by Sir Nigel Gresley in conjunction with Mr. Harold Yarrow. It was not a success. The degree of superheat took too long to build up and consequently there were greater condensation losses in the engine low pressure cylinders.

The boiler was not free steaming due to various causes, and the coal consumption was much higher by comparison with other standard Gresley "Pacifics." Various alterations were carried out in an effort to overcome these unsatisfactory features, but without success. Eventually in 1937 it was decided to completely rebuild the locomotive with a conventional type of boiler and a 4-6-4 wheel arrangement; it was, therefore, a non-standard type.

With regard to pulverized coal-fired steam locomotives, Mr. Harvey said it was quite true that several locomotives were working in Germany, but at the same time experiments were also being carried out in England, America, Brazil, India, Sweden and other countries. It was recorded that experiments were carried out in our own country as far back as 1916 by Mr. J. G. Robinson, Mechanical Engineer of the Great Central Railway. Papers concerning pulverized fuel burning in locomotives were contained in Journals 57, 88 and 91 of the Institution of Locomotive Engineers. Little progress had been made with regard to adopting any system for utilizing pulverized coal in the conventional type of locomotive firebox. The trend of dieselization and electrification in America and on the Continent had reduced or eliminated further experiments of this nature so far as steam locomotives are concerned.

Mr. G. W. Farquharson made reference to smokeless zones and the fact that railway locomotives were exempt within such zones.

Mr. Harvey said that the difficulty of the problem was appreciated, but an efficient transport system was necessary and, having regard to all the circumstances, it was considered that railway locomotives should be exempted in a manner similar to certain engineering and other industries which might be located within the proposed zones.

The figures quoted for the production of sulphur dioxide were taken from the Interim Report of Sir Hugh Beaver's Committee.

In connection with the training of staff, Mr. Harvey said that one of the great difficulties which faced the British Transport Commission in the training of staff was tradition, which was extremely strong on British Railways. It was hoped, however, to educate the staff at all levels to the importance of using effectively the fuel which was available and this would have an effect on the improvement regarding the emission of smoke.

Mr. Basford referred to the fact that a new housing scheme was being developed in close proximity to the Motive Power Depot at West Hartlepool.

Mr. Harvey said that in connection with the emission of smoke, a committee has reported recently on the most suitable type of locomotive shed roof, also on types of ventilators which can be applied to existing roofs. These are being provided as opportunity presents itself in repairs or replacement. No particular programme has been arranged for dealing with the depots; each one is considered on its merits. So far as a tall brick chimney is concerned, consideration was at present being given to providing one at a depot so that

experience may be gained as to the efficiency with the type of Motive Power Depots in use in this country.

Mr. Harvey said that he wished to thank Mr. Redstone for his remarks in connection with the training of firemen who are placed on shunting locomotives. In the first instance, this was, naturally, because the work from a fireman's point of view is much less arduous than would be the case on the Main Line and also the demands made upon the boiler were easy and intermittent. Should the fireman make mistakes by putting too little or too much on the fire at one time no great harm would result, whereas on the Main Line time would be lost, and probably, by reaction, time lost by following trains. It was felt, however, that the scheme for training young firemen was such that by the time they were allowed to proceed on to shunting locomotives they were quite capable of dealing with this class of work.

With regard to the proposal to increase the capacity of tenders or bunkers to enable them to carry coke for shunting purposes, Mr. Harvey felt that this presented a good many mechanical difficulties and, in any case, it was felt that the better solution here was the one being implemented, namely, to provide diesel locomotives for shunting purposes.

The author wanted to thank Mr. Nonhebel for his written contribution. The standard suspended smoke measurement as used by the D.S.I.R. was well-known to the physics section of British Railways and was used by them in their investigations in addition to measurements of collected solids from the atmosphere.

DEVELOPMENTS IN THE INDUSTRIAL USES OF GAS AND ELECTRICITY

(1) Gas

by

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1. The Industrial Gas Load

1.1 *General*

One relationship of Industrial Gas to smoke abatement may be interpreted by the statement that every gas-fired installation is a contribution to smoke abatement. There is a great diversity of processes in which gas plays an important part, and many are specialized in requiring gas or other refined fuels.

In discussing developments in the use of gas for industry, it must be appreciated in trying to cover this extremely wide field and in endeavouring to describe the part industrial gas plays in the economic life of the nation, the examples quoted are not necessarily cases where gas has replaced solid fuel.

Gas sold for industrial processes is now about 25 per cent. of the total load of the Gas Industry and its growth can be seen since the war by Table I, which gives approximately the quantities of gas sold to industry.

This growth has been accompanied by the parallel growth in industry of the desire for greater use of such facilities as line production and automatic ignition and operation of equipment, together with satisfactory performance with the minimum of labour and maintenance for long and arduous periods. In a great number of processes, these requirements are coupled with a strict need for close control of temperature, pressure and other physical factors. This has demanded a change of technique in design and operation of plants which, among other things, this paper sets out to record.

In general, developments mentioned are those which have been worked out over the last few years some of which which are just beginning to take effect.

The Industrial Gas load in itself shows wide variations. Naturally in the country or holiday areas there is substantially less concentration of industrial plant than in towns like Sheffield or Birmingham, and it can be said that where industry is thickest, there is the greatest opportunity for smoke abatement. This may take a variety of forms, since London, for instance, is the home of small industries and there are very many thousands of factories, each requiring an individual approach to its particular

Table I

(Millions of Therms)

	1945	1946	1947	1948	1949	1950	1951	1952	1953
Industrial ..	390	400	415	475	515	580	630	640	650

problem. On the other hand, in some of the big industrial centres the problem of smoke abatement may be largely resolved if it is possible to reorganize the activities of a few firms.

The size of plants concerned vary as widely as the loads or processes going on in them, and gas fired units are available in gas rates ranging from 50,000 cu. ft. per hour (250 therms) and more, down to a few cubic feet per hour. The small units must not be neglected, because collectively they can add up to a great deal. For example, Birmingham and district, a great industrial area, where the Industrial Gas load is 42 per cent of the total load, sold about 47 million therms in 1952-53 for this purpose, whereas the North Thames Gas Board, in London, a city not always considered an industrial one, sold about 75 million therms in the same period to industry.

London is not, of course, without its large organizations as the figures taken from a table in a recent paper by Tyrrell[1] show. In general, however, the processes concerned in London are many and varied and are not in the category of very large industrial gas installations.

Coal used in industrial processes is of the order of 35 million tons a year. Industrial gas is now consumed at the approximate rate of 650 million therms a year, which is considered to do the same work in the factories as 4.7 million tons of coal. Remembering the statement in Paragraph 2 of the paper, it could be argued that about 10 per cent. of a possible smoke problem is already being tackled by the Gas Industry. This is not inconsiderable and the activities of the Gas Industry in this direction are worth some attention.

It is only possible to deal with a fraction even of the more interesting examples of recent developments and it is proposed in the following sections to pick out a few of the more important subjects for discussion.

1.2 *Systems of combustion*

As stated before, there is an enormous diversity of processes using town gas as a source of heat, but the problems of combustion are relatively simple in that only three main burner systems are used, respectively called, pre-aerated, aerated and post-aerated.

A pre-aerated burner system is one in which primary air is mixed with the gas before arrival at the burner. These mixtures have specialized uses under rigid control.

An aerated burner system is one in which the gas induces primary air

Table II

(Number of Factories)

Regions	11-24 employees	25-99 employees	100-499 employees	500-999 employees	1,000-1,999 employees	2,000 and more employees	Total
London and South Eastern	4,595	6,145	2,207	273	130	61	13,411
Eastern	829	1,190	504	66	30	17	2,636
Southern	777	962	369	52	25	13	2,198
South Western	928	1,186	401	56	17	17	2,605
Midland	1,822	2,938	1,414	205	121	56	6,556
North Midland	1,295	2,031	936	111	30	28	4,431
East and West Ridings	1,862	2,761	1,478	160	54	29	6,344
North Western	2,437	3,917	2,295	220	84	76	9,029
Northern	613	938	460	95	35	25	2,166
Scotland	1,733	2,427	1,108	161	69	26	5,524
Wales	550	708	371	72	24	13	1,738
Total Great Britain	17,441	25,203	11,543	1,471	619	361	56,638

immediately before the burner ports. The well-known bunsen burner is an example of a low pressure burner of this kind.

The post-aerated burner system is one in which all the air for combustion enters as secondary air. This is an equally common method of burning gas, for instance, by the use of jets screwed directly into the pipeline or burner bar. The word " post-aerated " is not, so far, very popular and the system is more generally known by the incorrect and not entirely adequate terms of "neat" or "luminous."

These three systems can be subdivided into a number of modifications involving variations of pressure or aeration which between them cover the whole field of burning gas.

A particular requirement is best met by adaptation of suitable background knowledge and it is the great flexibility in the use of gas which enables all the variations of the above three systems to be employed in coping with any required problem. To quote one example, there are post-aerated burners which have capacities of 10,000 cu. ft. per hour, or more, down to one cu. ft. per hour or less, operating with stability at a range of pressures varying with the gas rate from hundreds of pounds per square inch for large burners to fractions of an inch water gauge for small burners. All this, if necessary, can be accomplished with one burner. Such a burner can cope with other fuel gases of varying specific gravity. With this and a variety of other burners, it is possible to deal with heat inputs of any required magnitude in a minimum of space.

2. Developments in some Basic Industries

2.1 *Ceramics and pottery*

It is perhaps in the fields of ceramics and the production of pottery that industrial gas and smoke abatement can be considered to go hand in hand in the most striking way.

Town gas in this industry is being used extensively, not only for firing clay ware, but, for example, drying, bone calcination and frit melting. The progress of gas fired equipment in the Potteries has been phenomenal and the field is now being extended to the firing of floor and roofing tiles and other heavy clay products.

The growth can be illustrated by the fact that before the war it has been estimated that one million tons of coal were used in the Pottery Industry only in Stoke-on-Trent. The change-over from coal to gas firing has helped to reduce this figure to 400,000 tons. In 1952, for instance, some 23 million therms of gas were used for pottery firing, to produce which the gas works required approximately 280,000 tons of coal. It is estimated that this quantity of gas replaced 336,000 tons of coal previously used in the raw state.

There are three main problems in the production of ceramics:

1. The firing of clay ware in the basic state at about 1,100° to 1,200° C.
2. The firing of glost ware at about 1,000° to 1,100° C.
3. The firing of decorated ware.

In all these cases, there is a wide range of gas heated plant and for large scale production the continuous kiln is rapidly assuming the most important role.

Progress in the firing by gas of continuous tunnel kilns is shown by the following table from German[2] giving installations in Stoke-on-Trent:

Table III

Year	*Consumption (cu. ft. x 10^3)*	*No. of kilns*
1932	7,443	1
1934	88,519	9
1937	617,148	48
1939	1,341,337	74
1945	1,223,450	84
1951	4,228,980	204
1952	4,760,570	229

By March 31st, 1954, 262 gas fired kilns were in use in the Potteries, together with 16 frit firing furnaces. The annual gas consumption for

pottery firing in the area rose to 24 million therms.

The many advantages of continuous tunnel kilns have been summarized by Davis[3] as follows: economies in fuel consumption, production of better ware, improved control of firing processes, reduced labour costs, better working conditions, reduced expenditure on saggers, continuous output of gas. In the continuous kiln, control of temperature across a section, and indeed of the whole firing cycle, is easy. Handling is reduced to the minimum and one particularly important point, the loss of heat, and wear and tear on the oven structure common in intermittent heating and cooling is very substantially reduced.

Fig. 1 shows one of the latest examples of a continuous kiln firing once-fired sanitary fireclay ware. This kiln is 416 feet long and has an approximate gas consumption of 47 therms per hour. It is a muffle kiln in which the system of combustion is a gas-air 1 to 1 premix by volume. This mixture is discharged at 3 p.s.i. through injectors which induce the remaining air required for combustion directly from the tunnel. Combustion takes place in a closed chamber set on either side of the tunnel. This arrangement gives preheated secondary air at a high temperature, about 900-1,000° C., ensuring economy in gas consumption.

The development of a good kiln is dependent, among other things, on suitable refractories and continuous improvements are being made. Economies can still be made by paying close attention to burner and combustion chamber design and the use of preheated air for combustion. A growing use is also being made of light weight insulating refractories, which have a low heat capacity and, therefore, enable a kiln to heat up quickly, but which are tough enough to enable quite strong structures to be built. Their low thermal conductivity and small pore size minimize heat losses. These advances are similar to those continuously being carried out in all branches of furnace design.

A valuable record of the work now being carried out particularly on the newer high temperature refractories is given by Dodd[4].

One point, if not peculiar to the

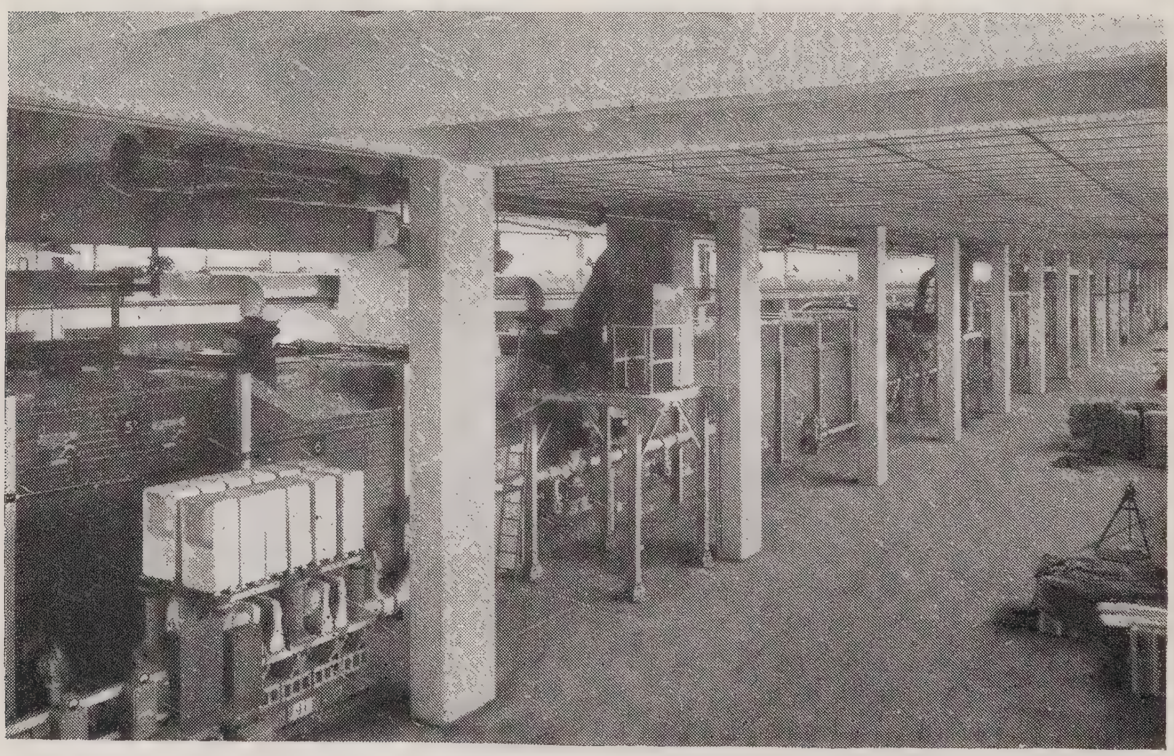

Fig. I

Pottery Industry, certainly of great significance, is the need to use saggers and large masses of car and kiln furniture to support the ware. Growing attention is being paid to the use of light-weight kiln furniture and where possible the use of open or direct fired kilns in place of muffle kilns. Such a design eliminates the need for expensive muffles and materially raises the thermal efficiency of the structure. It is not always possible to use such a system, but Fig II shows a view above the floor of the cars down the panel cooling zone of an open flame kiln for biscuit tableware, and demonstrates the length of a continuous kiln.

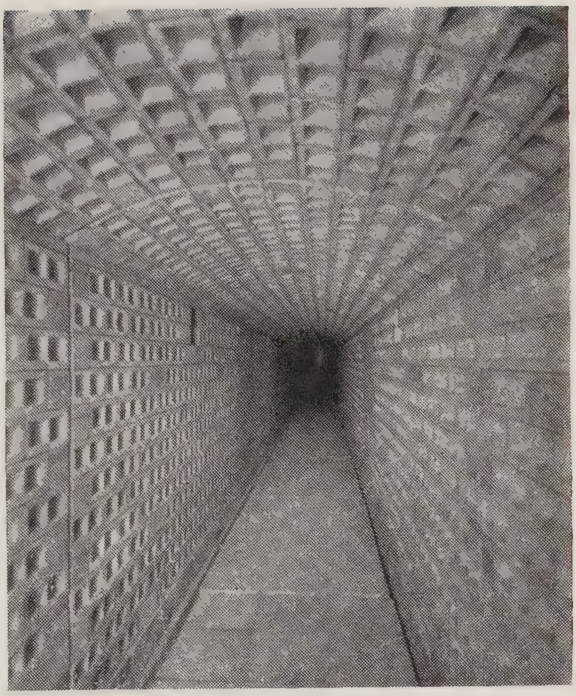

Fig. II

The smaller section of the Industry which concerns itself with educational, studio, or art pottery is an important one, which is spread more or less evenly over the country. The problems in this field are often economic in that kilns are required for the minimum price. On the other hand, even a small kiln is a piece of equipment carefully designed for its job and it should not be turned out by the amateur. To meet the need for the student or craftsman who wishes to indulge in the production of ceramic work, a variety of equipment operating at temperatures up to 1,450° C. can be produced. The lower temperature range up to 1,200° C. is of particular value to schools and educational establishments where increasing interest in the subject is being taken.

Fig. III shows a typical example of the art of the studio craftsman. Here, statuettes, dishes, plates and other work are being fired at temperatures in the region of 1,100° C.

2.2 *Steel*

Mr. W. L. Boon stated in 1953 that the coal requirements in the production of steel ingots and castings had been reduced from 39 cwt. per ton in 1928 to 29 cwt. per ton in 1948, a reduction of more than one quarter. This progress which undoubtedly in itself is a great contribution to smoke abatement is being increased by the growing use of refined fuels for metal melting and subsequent heat treatment. This advance has given an impetus to the need to learn a great deal more about the mechanism of combustion of such fuels and in 1946 large scale trials were initiated by the British Coal Utilization Research Association in

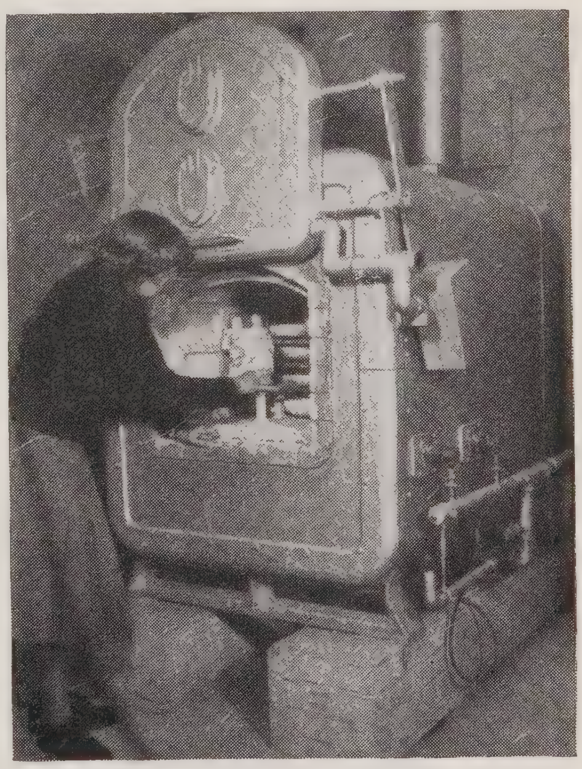

Fig. III

conjunction with open hearth furnace users.

Following this work, the conclusion was reached in 1948 that large scale work on combustion mechanism trials was necessary and as Professor G. M. Ribaud stated in his Presidential address at the Inauguration of the new experimental station in the Royal Dutch Steel Works at Ijmuiden in April, 1954, "During this probationary period or heroic era much was learned of the magnitude of the problem." Great enthusiasm resulted in the formation, in 1949, of the Flame Radiation Research Joint Committee, with Professor G. M. Ribaud as President, with which teams of French, Dutch and English technicians have worked closely together. This joint enterprise has become famous for its fundamental work which has been fully reported in successive issues of the *Journal* of the Institute of Fuel[5].

The Committee, now strengthened by representatives from America, Belgium, Sweden and Germany has developed techniques for the study of the characteristics of combustion by two main schemes:

1. Combustion mechanism trials.
2. Combustion performance trials.

As Professor M. W. Thring has stated, two aims of Flame Radiation Research have been to provide designers with exact data for predicting the performance of flame heated systems and, in addition, to provide an understanding of the fundamental mechanism of heat transfer with a view to developing ways of maintaining fuel efficiency and output. Latest work on this subject is summarized in a series of papers introduced by Thring[6].

Gollin[7] has recently discussed the subject of radiation and furnace design from which can be gauged the great importance of this work. Results carried out under full scale conditions have been reported on a number of oil burners and oil burning systems, coke oven gas, with or without the addition of oil, and in the near future, work will be going ahead on pulverized fuel.

The Gas Industry has a great interest in this work, although naturally the amount of coke oven gas used for large scale metal melting and treatment is still relatively small compared with other fuels, which of course, must be studied more closely at the moment. The great value of the work, however, lies in the acquisition of fundamental knowledge on the mechanism of combustion which cannot fail to be of substantial value to all furnace builders.

To quote from the address of Professor O. A. Saunders, Chairman of the Flame Radiation Research British Committee at the Ijmuiden meeting mentioned above:

> "It is obvious that even one per cent. saving in fuels in industries which may be affected by Flame Radiation Research would be well worth while. Such industries include iron and steel furnaces, coke ovens, gas works, bricks and refractory furnaces, cement kilns, china and glass furnaces and electricity generating plant. It is generally agreed that for the lack of precisely the kind of data we are trying to obtain, the design of furnaces has in the past been largely an art, and it is inconceivable that a more scientific approach would not lead to more immediate improvements. Beside the improvement in fuel consumption, there is the perhaps more important improvement in output and life of furnaces which could be very significant indeed."

This work is a striking example of the value of international co-operation in a project which was too big for any one organization or even one country to tackle and since the work of Chesters[8] and others on flow patterns in furnaces, substantial savings in fuels requirements for all sizes and types of furnaces are already evident. Some information on this subject was given by Hayman[9].

The improved performance of furnaces following the above work which will produce an appreciable saving of

Fig. IV

fuel, is in itself a substantial contribution to smoke abatement.

2.3 *Bread and biscuit baking*

This industry is of vital importance to the well being of the nation. The hygienic preparation of food is receiving close attention and Fig. IV shows a drawing of the type of modern bakery for which plant has to be designed. This represents a unit of a bakery where bread, and possibly confectionery, is made in a continuous plant on a large scale and where close control of baking conditions is essential. Such control is equally necessary in the smaller bakery where continuous plant may be justified, but the required output is less.

Fig. V. shows an automatic unit producing about 1,200 loaves an hour. In this particular oven some of the products of combustion are used to heat the final prover. The picture shows the economy in manpower possible in modern plants giving high rates of production.

There are very large numbers of even smaller bakeries where output does not justify the installation of a continuous oven, but where batch operation of a wide variety of bread and delicacies to serve the local community demands a unit capable of quick response and the maximum use with the minimum of heating up time and maintenance.

Fig. VI is a photograph of a small family bakery producing bread and small goods for selling to the public over the counter. In this small, but attractive bakehouse, there is little space for anything but the tools for the job. The ease of control of the equipment ensures a high rate of good quality production.

The gas baking load has grown enormously as shown by the figures for

Fig. V

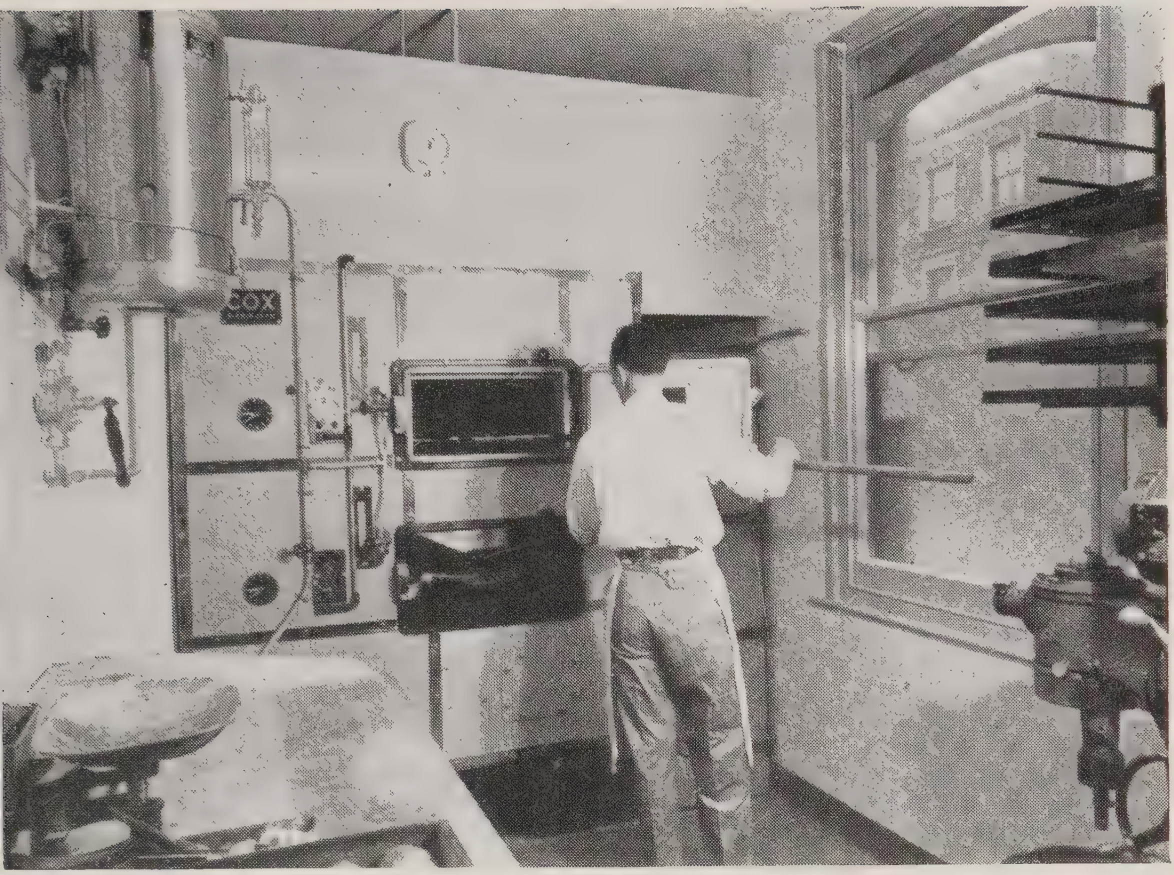

Fig. VI

recent years in the area of the North Thames Gas Board:

Table IV

Year	*Therms*
1945	650,000
1946	880,000
1947	1,300,000
1948	2,000,000
1949	3,000,000
1950	4,000,000
1951	5,000,000
1952	6,000,000
1953	7,000,000

In spite of the many advantages of gas for baking, it may be that economics will control the growth of the load for the time being, but progress in design must still go on and the high standards which improved conditions of food manufacture demand can readily be met by gas heated equipment.

A similar story can be told of biscuit manufacture, an industry in itself, where production is virtually continuous. Fig. VII is a picture of the delivery end of the twin line travelling band ovens showing the typical conditions in which modern plant works. Such units may be called upon to work for 20 hours a day with precise predetermined conditions which can be changed rapidly if a modification to programme or another type of biscuit is required.

New developments in ovens for all purposes and for a variety of food preparation are now active and the limit in operating performance has not been reached by any means.

The mechanics of baking have not been studied as fully as they might have been and there is no doubt that the rate of heat transfer to food in cooking can be improved with subsequent economies in operation.

2.4 *Metal treatment*

There is a considerable load in processes falling under this very wide heading and as in the rest of the paper, it is only possible to consider a few

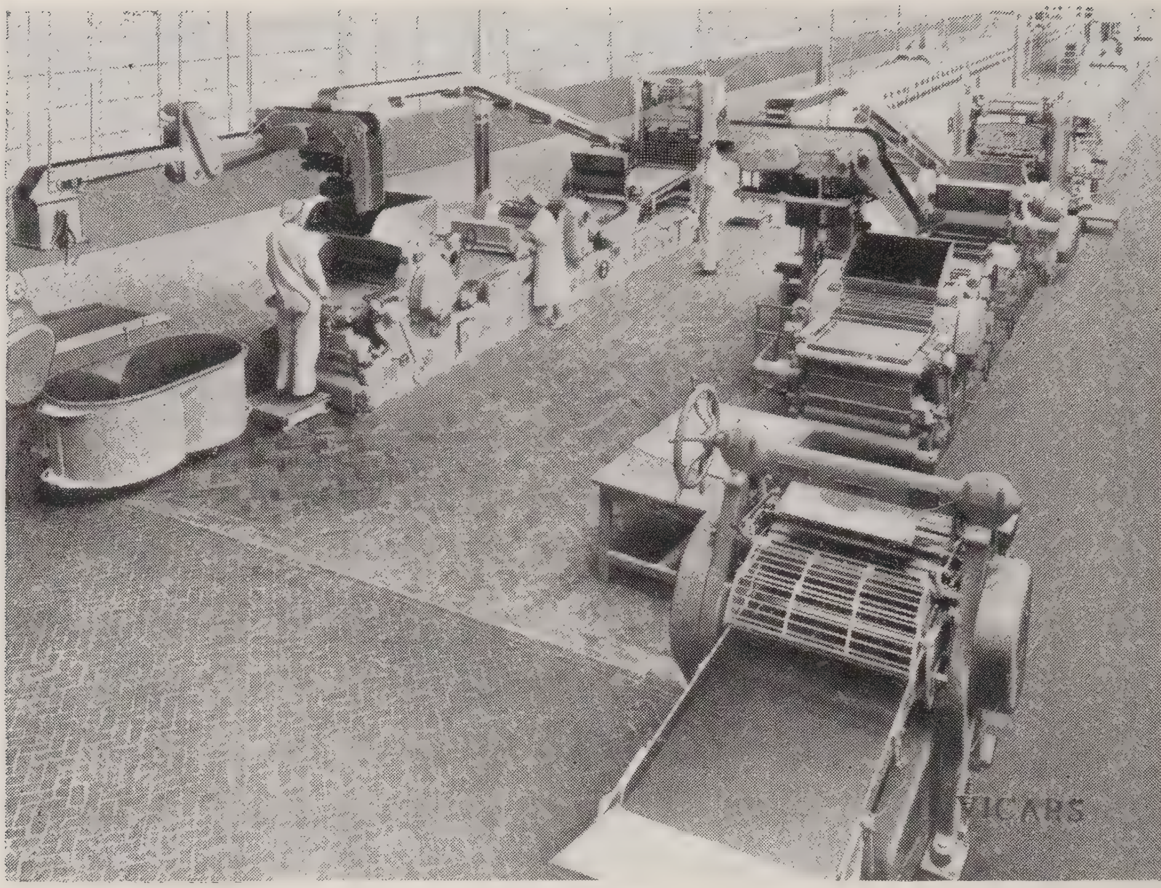

Fig. VII

applications where new advances are being made.

Section 2.2 referred to the work going on in improving the design of heating furnaces in the Steel Industry. Such work has been extended to all sizes, types and makes of furnaces. A great number of heating problems demand special technique for metal handling, which, if not particularly profound calls for modifications to standard practice. This, of course, is where the great flexibility of gas operaed equipment can help, and Fig. VIII shows a typical example of a gas fired walking beam furnace for heat treating the stabilizer springs for motor car suspensions. This particular furnace, which is operating on coke oven gas, which could of course be fired quite as well with town gas if the situation required it, heats a variable output of 30—100 bars per hour up to 960° C.

The bars are placed in a vertical magazine at the charging end of the furnace and fed on to an elevator conveyor before being placed in "V" grooves on alloy steel walking beams which progress the bars slowly through the furnace. At the end of the traverse the bars roll off the end of the alloy steel beam down a discharge chute which is provided with alloy steel flap plates for minimizing infiltration of cold air into the working chamber. After dropping on to the discharge hoops, the operator places the bar in a hydraulic bending and quenching machine seen on the left of the photograph. After quenching, the bars are tempered in a batch recirculated atmosphere gas fired furnace.

This furnace is automatically controlled and fitted with temperature indicating and recording equipment. An important point in this case was the limitation of floor space, virtually no room at all being available for anything other than the working zones and the operator.

It will be understood that the general subject of heat treatment is very wide

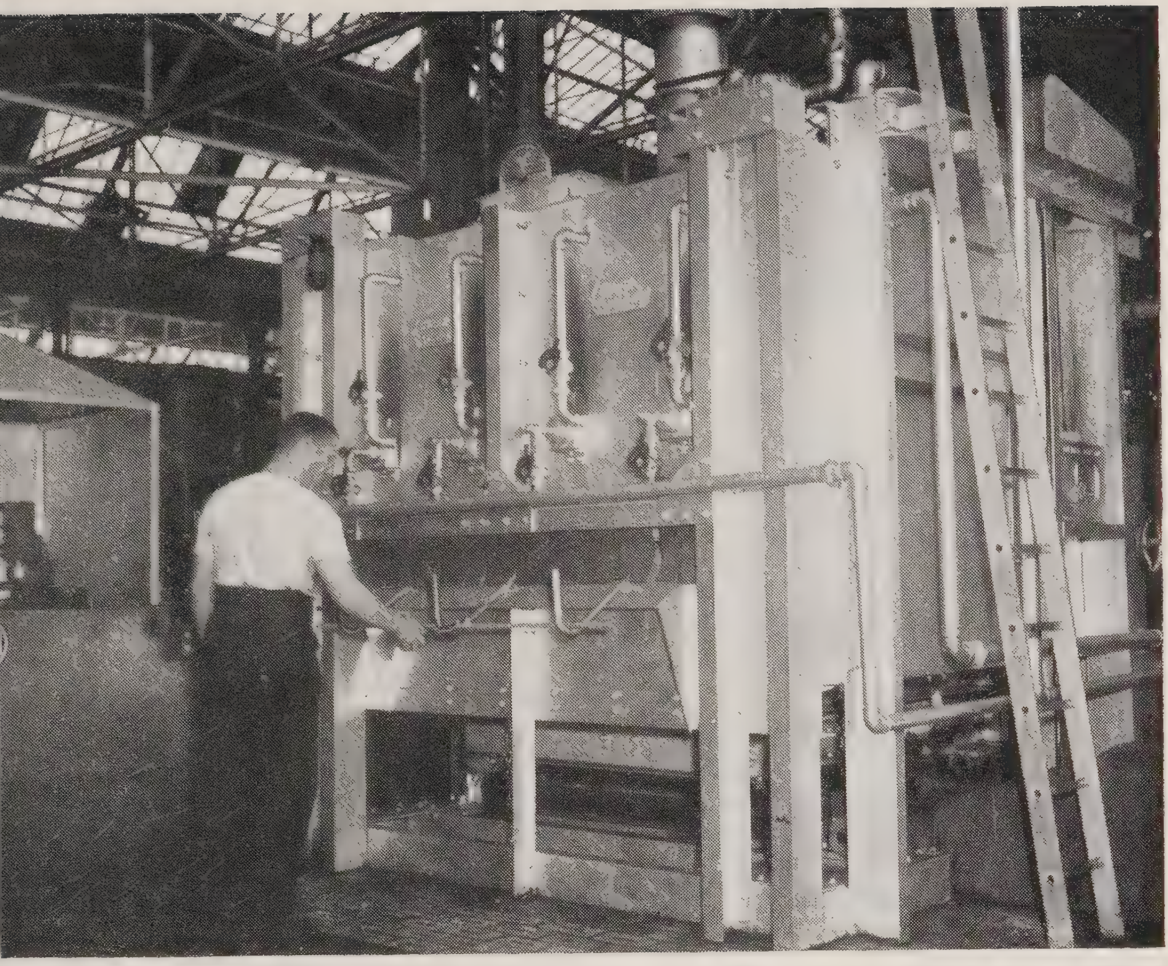

Fig. VIII

[a]nd covers problems of all magnitudes. [G]as is not without its share of very [l]arge installations, particularly in the [f]ield of stress relieving.

In recent years the development of [t]he oil industry in this country has led [t]o furnaces being installed by welding and fabricating companies of sufficiently large size for the necessary stress relieving and annealing of the welded pressure vessels which so often are of considerable size.

One of the largest furnaces in the British Isles for this purpose, shown in Fig. IX, is installed at Motherwell. It is of the bogie or carbottom type, with a width of 14 ft., a height of 15 ft. and a length of 56 ft. This furnace is capable of dealing with vessels up to 100 tons in weight. It has burners having a capacity of 115 therms of gas per hour, and four zones of temperature control.

It is built of light weight insulating refractory with the exception of the bogie, which must withstand the heavy charge. Further details of this plant are given in[10].

Fallon [11] has referred to further recent outstanding installations among which is quoted a plant heated by coke oven gas consisting of transportable lift-off furnaces each weighing 60 tons and each handling a load of four stacks of six feet diameter steel coils 15 feet high. The total weight per charge is 350 tons. Annealing is carried out in a gas of high nitrogen content generated from the heating gas. The entire plant is 1,300 feet long and produces 10,000 tons of bright steel strip per week for a consumption of approximately 20 million cu. ft. (100,000 therms) a week. It is the largest plant of its type in Europe.

There are very many furnaces in action which are carrying out their

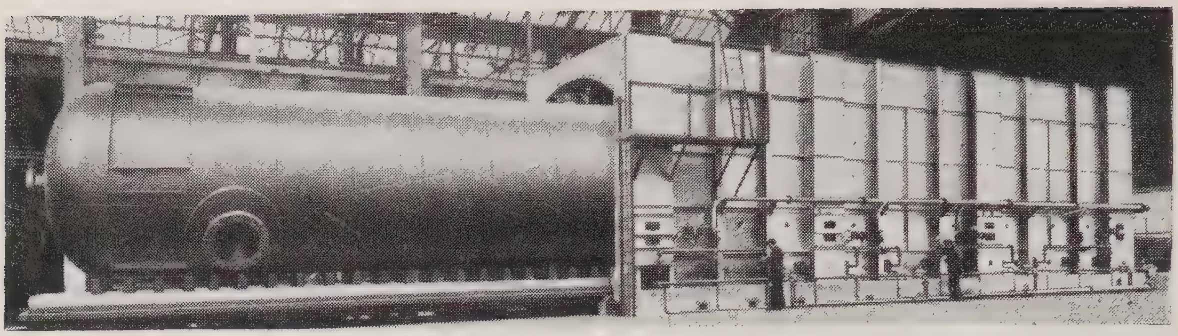

Fig. IX

duties satisfactorily, which, for economic reasons, cannot yet be replaced by newer designs, or by plants working on alternative fuels. It is often possible, however, to make some modifications to technique which can allow gas to assist materially in the operation of the existing plant.

A small but important contribution of this nature to smoke abatement is shown in the example of a firm possessing many pulverized fuel forge furnaces which, in the morning, were lit by throwing lighted oiled sacks into the combustion chamber. This method of ignition resulted in the production of large volumes of black smoke and the emission of unburned pulverized fuel. Each furnace was equipped with a large air-blast gas burner which functioned during the ignition period of the pulverized fuel and enabled ignition to take place without the emission of smoke or grit.

Other examples of elimination of smoke nuisance could be quoted.

There are many operations where crude heat treatment processes can produce the desired effect and where a refined fuel is too expensive or not available in sufficient quantity. Some forging operations fall in this field.

On the other hand, greater demands in the operating requirements of many things from turbines and rockets to lathes and railway engines have led to corresponding advances in the production of superior ferrous metals and non-ferrous metals and other alloys. Many of these metals require heat treatment which, if not necessarily more complicated than hitherto must conform to a particularly close cycle of operations. Manual skill in such important tasks as surface hardening is acquired only by long experience and keeping pace with the great output of the newer materials requires some addition to the skill of the trained operator.

An example of new developments in this field is flame hardening by town gas.

Flame hardening by oxy-town gas has been common on the continent for some years, but is not so well known in this country. The biggest problem with all forms of flame hardening has been the risk of overheating calling for considerable skill and experience on the part of the operator. This risk has now been eliminated by taking the control substantially out of the hands of the operator and placing it in the care of an ingenious design of radiation pyrometer which acts as a process controller.

The parts to be treated are heated by a specially designed burner, usually tailor-made, which burns gas and oxygen under controlled conditions.

The burners are immediately followed by a water quench. The heated area is "watched" by a temperature controller which maintains constant pre-set temperature conditions on the surface of the work by continuous alterations, if necessary, of the speed of traverse of the burner over the object being treated. With precise control of the pre-set temperature condition the degree of surface hardening is similarly controlled.

The great advantage of such a system is that it is completely flexible, and by designing suitable traversing gear components of sizes ranging from an inch or so to many feet in length or diameter can be tackled. Such important parts as gears, sprockets, crank shafts, pins of all kinds, and many other bearing surfaces are being flame hardened by town gas in large quantities.

Fig. X shows the progressive hardening of lathe beds. A full description of this plant is given in [12].

This new technique, co-ordination of automatic control with the well known advantages of town gas, has opened up another large new and interesting field for development.

2.5 *Glass*

Melting, forming and subsequent heat treatment of glass is a large industry with numberless ramifications. Large scale melting by gas like many other heavy operations is possible only if an abundant supply of cheap fuel is available. Production of glass shapes such as bottles and similar containers on an enormous scale by automatic machinery demands very close control of temperature of the glass being fed to the plant, particularly as the shape, size and weight of the finished article usually are rigorously controlled by the consumer's specification.

The importance of temperature control is indicated by the fact that normally, to minimise rejects and to ensure satisfactory production, variation in the temperature of the glass tank feeder must be of the order of plus or minus 2° C.

Many plants are now being equipped with gas heated feeders which ensure the close control required. Glass tank feeders are long, shallow, closed refractory structures placed just below the glass line of the melting furnace and are built outwards to a length varying from 5 ft. to 20 ft., or even more. The length is dependent upon two factors, one being the space available for positioning of the automatic machines and the other, the

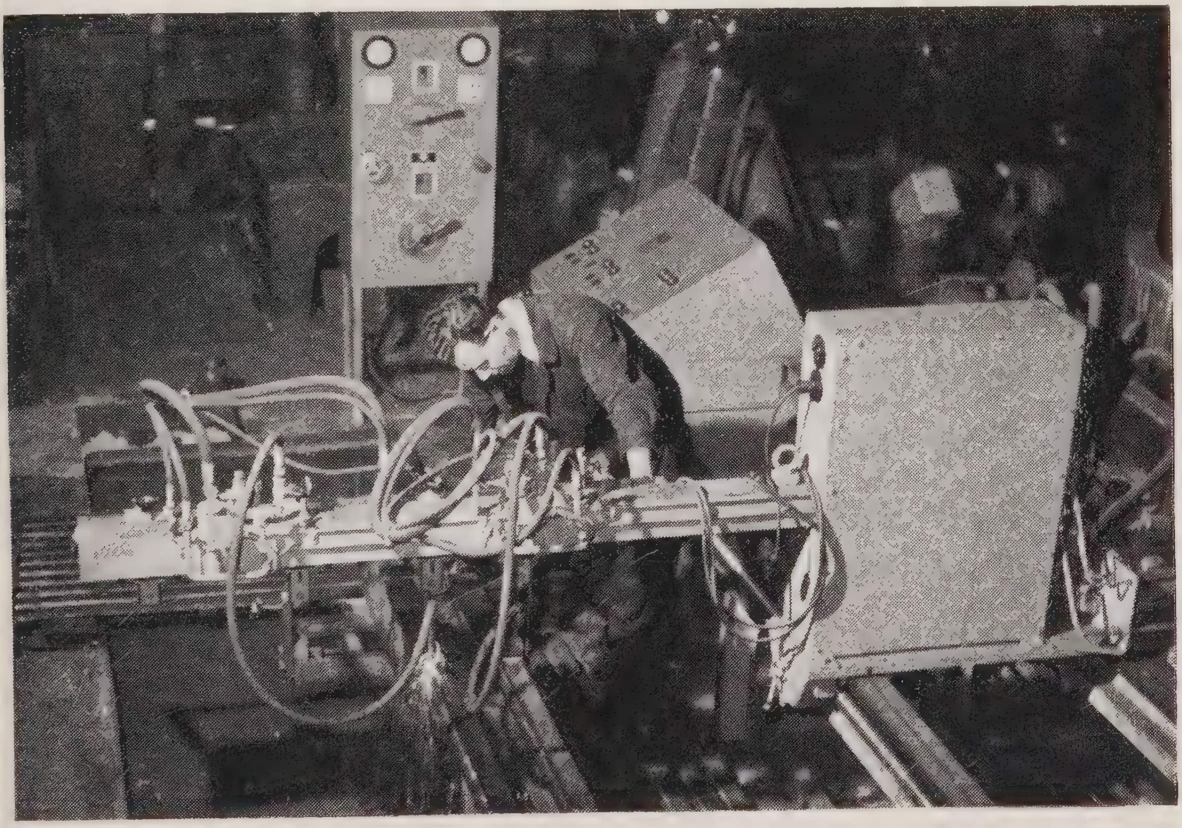

Fig. X

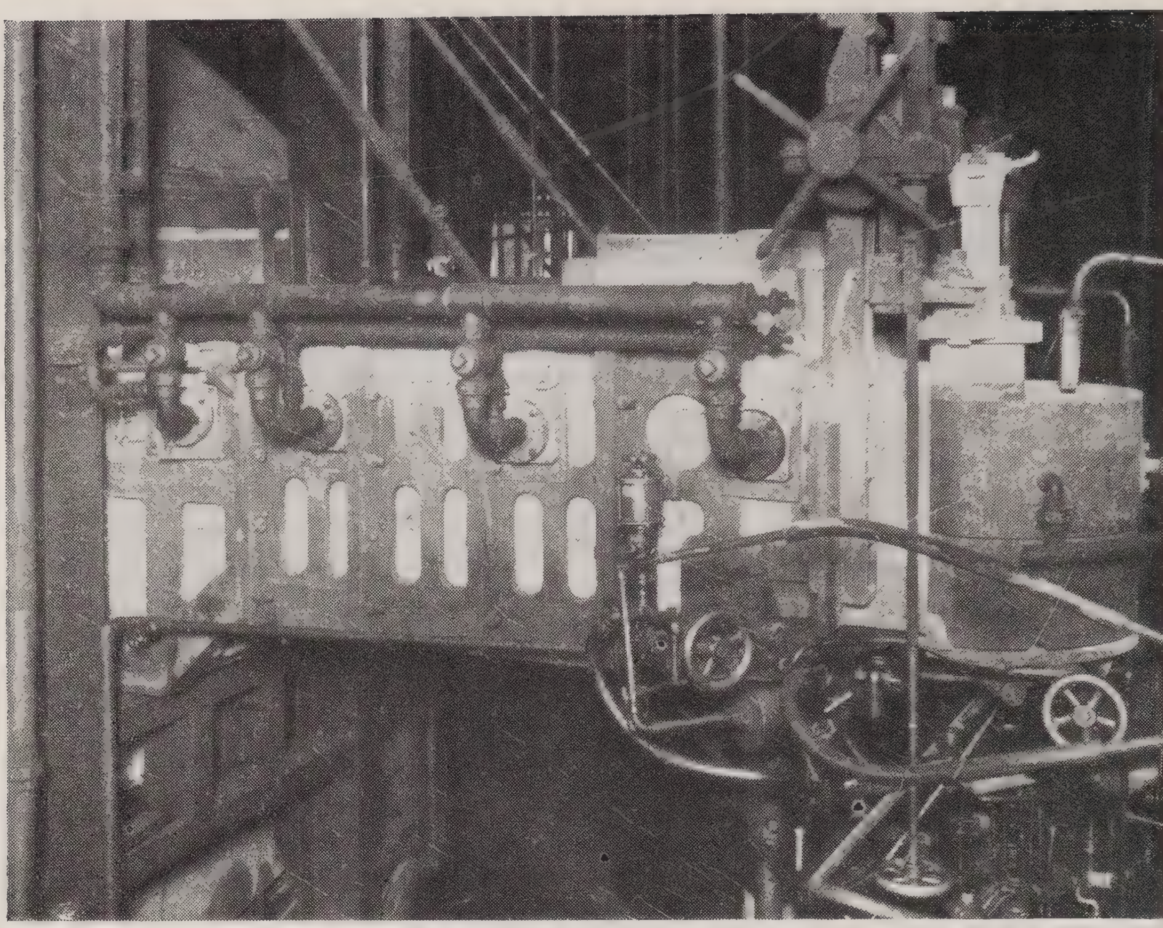

Fig. XI

length of the feeder which is considered necessary to gain control over the temperature of the glass after it leaves the tank furnace. The glass flows into the feeder from the tank furnace and by gravitation makes its way towards the outer end, in a shallow stream. There, it is literally pushed through a small hole by means of a refractory plunger working in a sleeve and at the end of its stroke, the glass is cut off by means of shears, both the plunger and the shears being operated by compressed air and synchronized to work with the machine.

The smaller the object being made, the slower is the rate of flow of the molten glass along the feeder length, with a consequent greater gas consumption required to maintain the feeder temperature, as the heat losses from the structure remain constant. Conversely, the larger the object under manufacture, the more is the heat supplied to the feeder by the glass flowing from the furnace.

Heating of these feeders is commonly carried out by town gas to ensure the closeness of temperature control which is essential. Fig. XI shows a typical view of such a feeder.

These plants are large gas users and one tank may well consume hundreds of thousands of therms in a year.

A recent development, where a new production technique is linked to a need for a very large output, is in the production of television tubes. This process again demands close control of conditions to ensure that the large surface area of the tube shall be free from strain. There is a variety of methods now employed using a combination of heating and annealing by radiation and convection. The design of plants varies according to the size and shape of the tubes, but they are all necessarily complicated by the need to co-ordinate many operations including heating, removal of unwanted glass round the neck, exhausting and sealing.

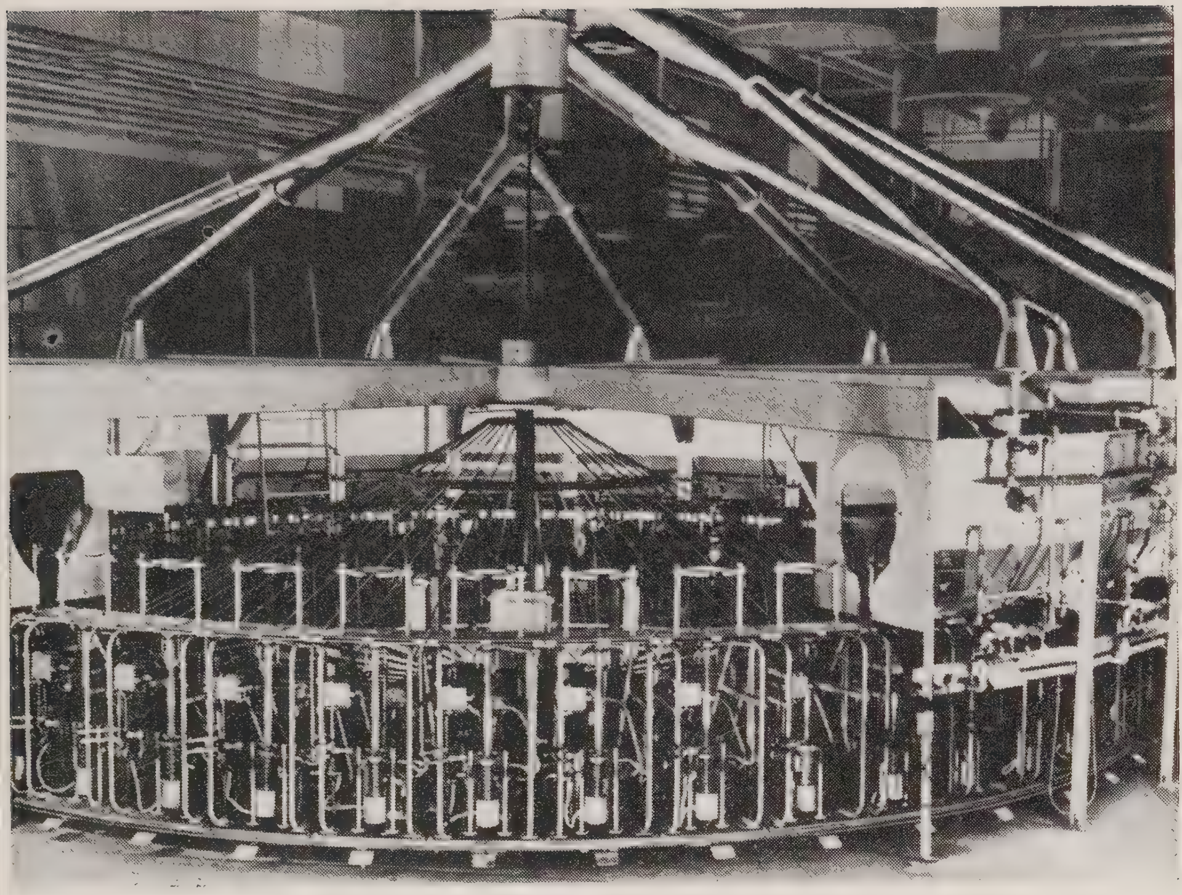

Fig. XII

Fig. XII illustrates this point in showing one system of treatment. Further work on this subject is described by Lockwood and Davies[13]. Fig. XIII shows the delivery end of an annealing lehr.

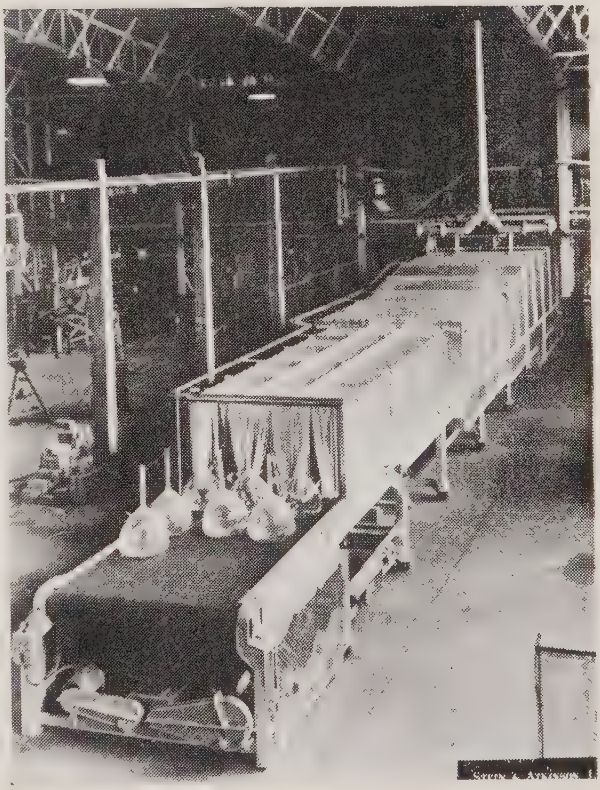

Fig. XIII

3. Developments in Equipment of General Application

Modern equipment requires to be operated under conditions of increasing severity. The jet engine and the rocket are examples where substantial developments in metallurgy and ceramics have made a high performance possible.

Such requirements, in turn, demand the ability to conduct research, development and production at increasing levels of temperature. Where, for instance, 1,350° C. used to be adequate for most heat treatment processes, this figure has now been raised in special circumstances.

3.1 *For high temperatures*

Equipment is available for a great variety of operations at increasingly high temperatures which, until recently, had about 1,800° C. as a general upper limit. Recent advances in furnace design coupled with the availability of superior refractories have enabled a temperature of 2,100° C. to be rapidly achieved and held in practice in a chamber of appreciable size, at the moment about 15 in. by 14 in. by 14 in.

Fig. XIV shows the prototype on the Gas Council stand at the 1954 British Industries Fair, Castle Bromwich, where it was shown for the first time.

The combustion chamber of the unit consists of stabilized Zirconia backed by appropriate courses of insulating and refractory materials. The combustion chamber ports designed to produce a pre-conceived flow pattern for the products of combustion lead on each side into a reversing regenerative system, which, equipped with automatically pneumatically operated reversing valve gear, gives preheated air temperatures of the order of 1,500° C. This is achieved by producing regenerators of suitable mass having high rates of heat transfer.

The ability to achieve a temperature in excess of 2,000° C. will open up several new important fields, in the first place, for research and development into such important subjects as high temperature ceramics and metallurgy. The size of the furnace now available will enable the behaviour of materials to be studied on a scale not previously possible at this temperature.

3.2 *For medium temperatures*

The last war stimulated a great demand for the rapid production of a large variety of objects protected with paint or other coatings. Many systems of drying and curing paint and metal objects were put into use. Some, if not exactly smoke producers, cer-

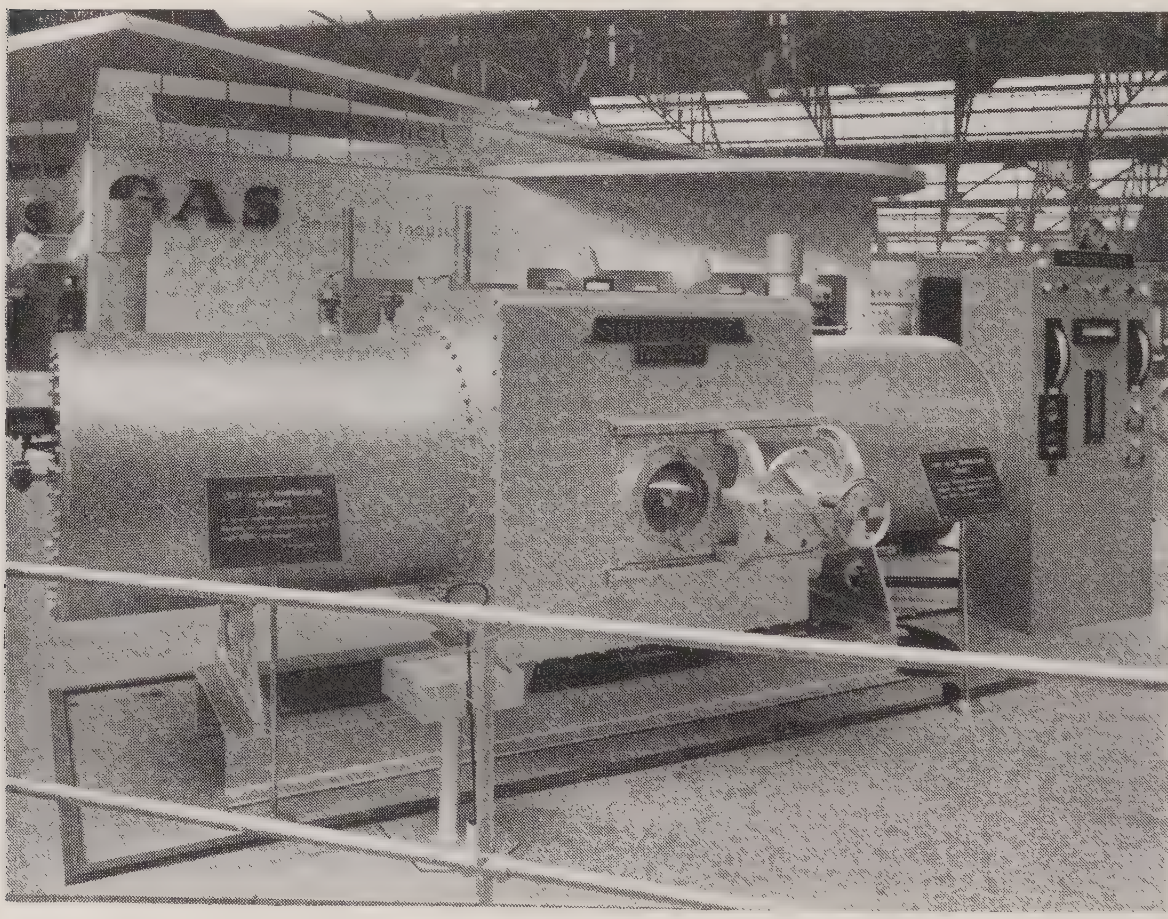

Fig. XIV

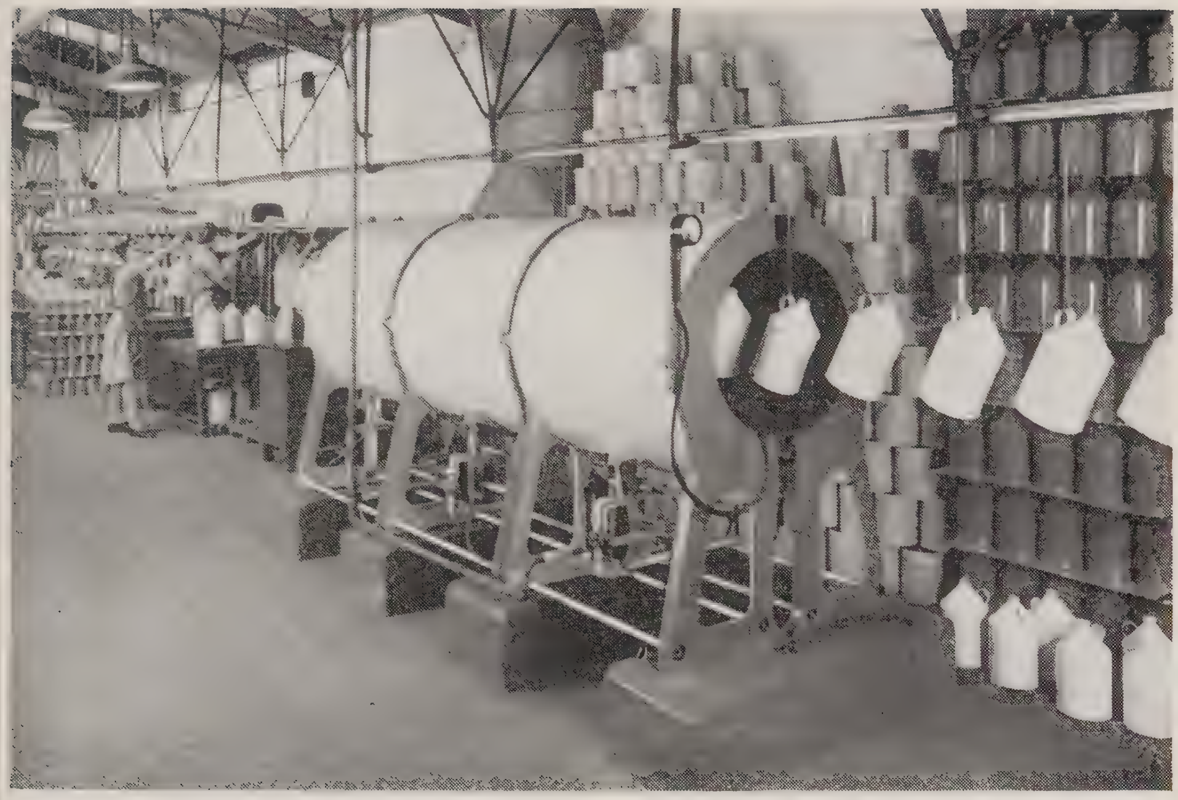

Fig. XV

Fig. XVI

tainly made a contribution to atmosphere pollution.

The great demand stimulated production of plants for rapid curing and in the last ten years installations have steadily grown. The type of plant depends on the work being done and a satisfactory combination of drying and curing by radiation or convection can be found for every requirement.

For some years there has been a rapid growth of radiant heating plants and some hundreds of gas heated tunnels and many thousands of panels are in regular use. There is some resurgence of interest in the use of tunnels, which, although not having the same flexibility as panel systems where large and weighty shapes require to be treated, show advantages in the treatment of a flow of objects of reasonably consistent size.

Fig. XV shows three 2 ft. diameter tunnels finishing the paint on cans in $1\frac{1}{2}$ minutes at a tunnel temperature of 650° F.

Forced convection plants continue to extend in numbers and in the uses to which they are put.

Fig. XVI shows a small camel back forced convection conveyor oven used for curing of the finish on small metal components. The oven is fully instrumented with an electronic flame failure device linked to a purge timer and automatic ignition. This is a typical example of the application of improved methods of automatic control to gas equipment.

The photograph above was taken on the Gas Council stand at the 1954 British Industries Fair, Castle Bromwich.

In all such equipment there is close control of the finishing conditions with the elimination of overheating and other undesirable results.

Fig. XVII shows an interesting installation where gas has replaced steam for heating paper-making machines. It is believed to be the only installation of its kind, certainly the only one

Fig. XVII

in the British Isles. Surface combustors suspended inside each cylinder give a radiating area of about 45 inches by 5 inches. The burners remain stationary while the cylinders rotate and with 27 cylinders the total gas rate is approximately 18 therms per hour. The time for heating up the drum from cold to the working temperature is ten minutes. The machine can then go on to full production. Higher temperatures up to 400° F. can be obtained on the drum if required.

3.3 *Direct fired air heaters*

The use of direct fired air heating is of long standing, but there is a growing field for this method of heat application. Direct firing has many advantages including quick heating up, rapid approach to equilibrium conditions and high thermal efficiencies approaching 90 per cent. Two examples of widely different applications can be quoted.

The Iron and Steel Foundries Regulations [15] lay down, among other clauses, the following which come into force on 1st January, 1956:

(1) Open coal, coke or wood fires of a portable nature shall not be used for the purpose of heating workrooms.

(2) Open coal, coke or wood fires shall not be used for heating or drying ladles inside a workroom unless adequate measures are taken to prevent, so far as practicable, fumes or other impurities from entering into or remaining in the atmosphere of the workroom.

(3) No open coal, coke or wood fires shall be used for drying moulds except in circumstances in which the use of such fires is unavoidable.

(4) Mould stoves, core stoves and annealing furnaces shall be so designed, constructed, maintained and worked as to prevent, so far as practicable, offensive or injurious fumes from entering into any workroom during any period when a person is employed therein.

This has meant some demands for alternative methods of heating.

A direct fired air heater now available consists of a burner which is stable in an air blast produced by a fan. The excess air generated mixes violently with the hot gases from the burner, which is mounted in a refractory chamber, and the resultant stream of warm air is directed to where it is required. The equipment is automatically controlled and is fitted with a flame failure device.

A predetermined air temperature up to 800° F. can be produced as required. The value of such a unit in foundries is to be able to dry sand moulds continuously and uniformly without any local overheating. Moulds dried by this method are clean and ready immediately for casting. There are several designs of core and mould driers which have in a number of cases replaced ovens fired with solid fuel.

A similar technique is adopted in generating hot air which is fed to a spray drier employed for the production of a synthetic cream which is sold in powder form. Spray drying in this case is particularly suitable since prolonged heating at high temperature would cause deterioration of the product. Further, the product, after spending a controlled minimum time in the drier, leaves ready for marketing without further processing. Direct fired air heaters take the minimum amount of space and in this case, the unit can be accommodated close to the drier without the need for a separate building.

The heater, designed to operate at a maximum rate of 15 therms per hour with a maintenance rate of about half this figure, is only 9 ft. long by 3 ft. in diameter. This unit operates under completely automatic control and is fitted with an electronic flame failure device. The ease of operation possible with such plants is always regarded by the operators as a great advantage.

3.4 *Steam boilers*

The great bulk of industrial steam raising plants are solid fuel fired and

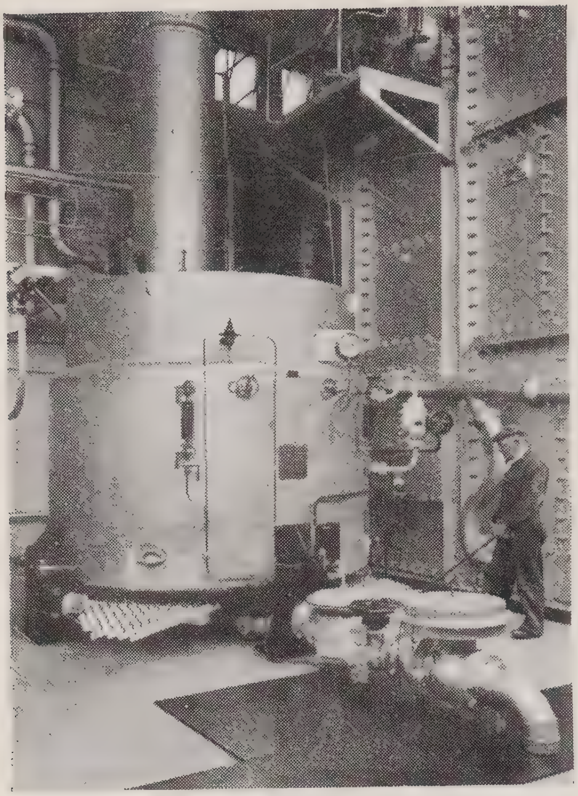

Fig. XVIII

do not come within the scope of this paper. Gas is limited for economic and supply reasons to heating the smaller units with a maximum of about 10,000 pounds of steam per hour.

Thousands of boilers are in constant use, having capacities of the order of 100 to 1,000 pounds of steam evaporated per hour, and Fig. XVIII shows an example of a large gas fired boiler fitted in the boiler house of King's College, University of Durham, Newcastle-upon-Tyne.

This boilerhouse is a magnificent example of its kind. The boiler shown is 8 ft. in diameter by 9 ft. 3 in. and delivers 4,800 pounds of steam per hour at a pressure of 160 p.s.i. The maximum gas rate is 64.5 therms per hour.

Two other large gas fired boilers make up the installation with an approximate capacity each of 6,000 pounds per hour of steam. The boilerhouse has three main functions:

(1) To heat the building.

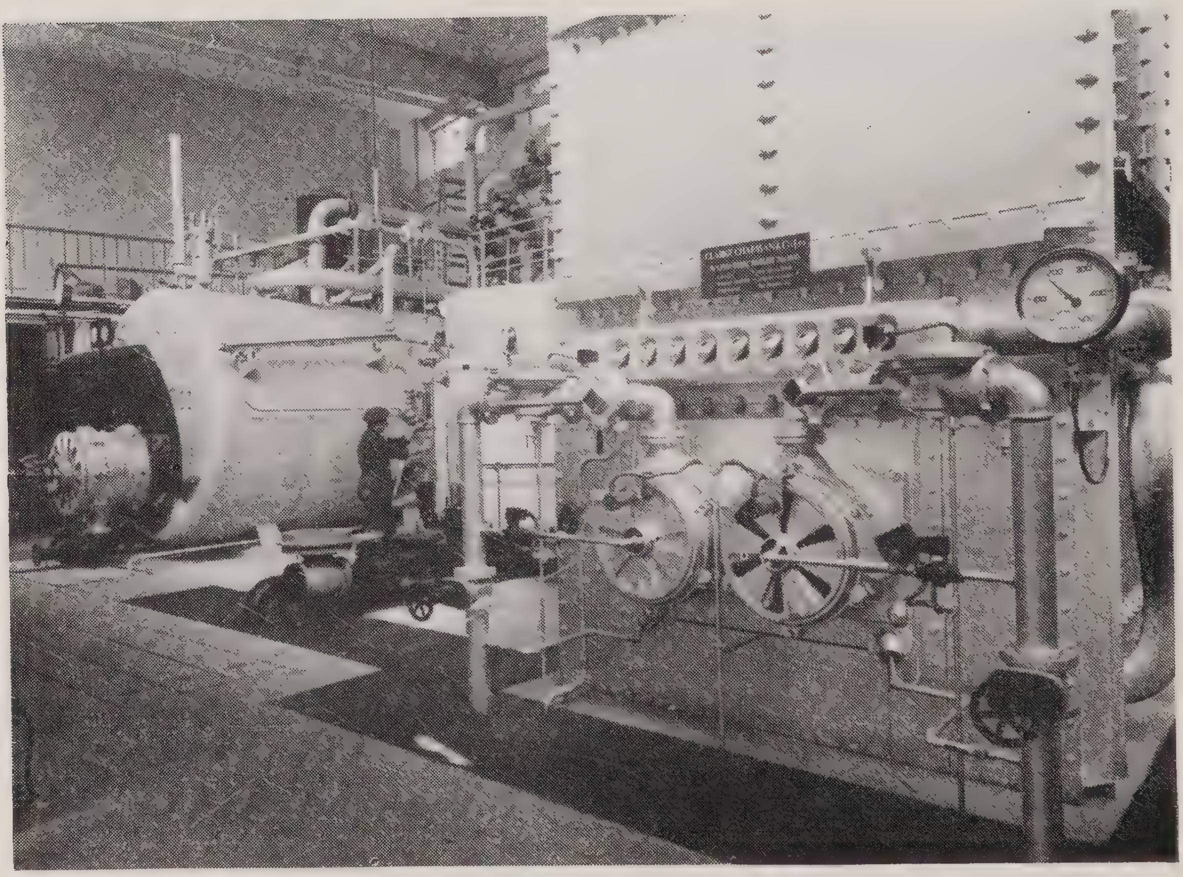

Fig. XIX

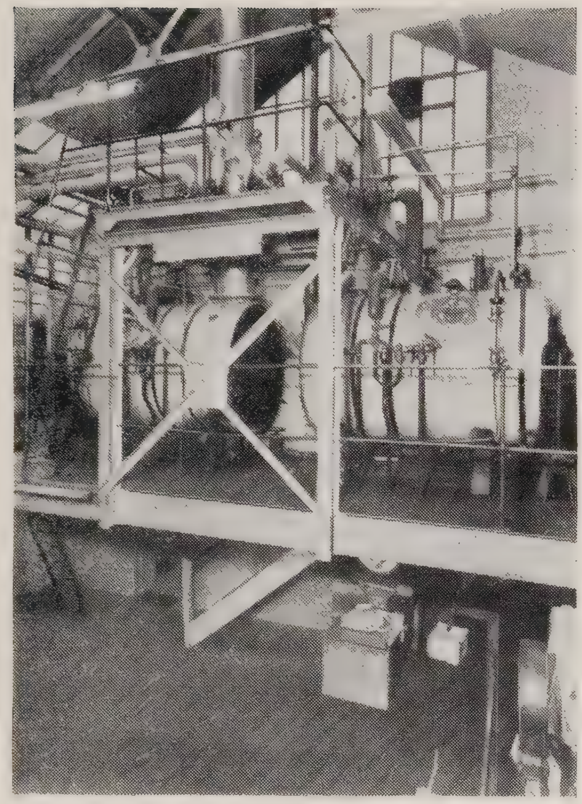

Fig. XX

(2) To supply superheated steam for the testing of steam engines and turbines in the engineering shops.

(3) To be used for instructional purposes by the students.

Fig. XIX shows a general view of the boiler house.

An interesting installation is shown in Fig. XX. The plant supplies steam which is used for space heating and through a calorifier supplies hot water for washing food machinery. The combined capacity is 2,800 pounds of steam evaporated per hour, with a total gas consumption of 36.7 therms per hour.

The former coal fired boiler was installed at floor level, but by raising the whole of the new installation to the high level shown in the photograph considerable floor space was freed, in addition to that which became available by the elimination of the coal storage space. Space was the most important consideration, apart from the improved cleanliness and the saving of labour, in view of the rapidly expanding growth of production. It has been possible to put the boilers into the existing factory space and food can be processed with complete confidence in the same area.

In a highly congested area, such as the City of London, where storage space and floor space are at a premium, there are approximately 400 gas fired steam boilers of all sizes serving a great variety of processes. This indicates the great contribution of gas to smoke abatement in areas of this kind.

4. Special Activities

There is a steady growth in processes demanding remote control and automatic ignition. This requires plant to be built with control devices designed to eliminate the risks of inadequate or faulty operation and flame or pressure failure.

Complete control of operations, particularly in respect of temperature and combustion conditions, is itself a major service in the cause of smoke abatement.

The Gas Industry has for years been carrying out work on the design and development of such control devices and has laid down standards for their installation and layout.[15, 16]. This work which is proceeding steadily, will enable a greater range of equipment to be made available for all industrial practices, conforming to the requirements of Industry and those of the Factory Inspectorate.

An example of the great interest in this subject is given by the paper recently read by Haslock[17].

It is difficult to quote examples of the many activities of general and special interest without the paper becoming disjointed, but mention should be made of a minor smoke abatement development which has recently occurred in the process of bacon smoking.

The older method of smouldering sawdust has been replaced in one design by a gas heated floor. By adequate control of the heat input, the amount of smoke coming from the plant has been cut by 80-90 per cent. Further, the sawdust consumption is less than

one-tenth of that used in the older method, and for long periods the quantity of smoke emitted from the house is so small that it can hardly be noticed.

5. Service to Industry

The work outlined above cannot be really effective unless the fullest use is made of the service the Gas Industry can give to consumers.

For many years there has existed a scheme for co-ordinating and disseminating technical information and advice on the subject of Industrial Gas. Responsibility for this has been vested in the Industrial Gas Development Committee of the Gas Council which consists of Industrial Gas Officers or representatives of all the Boards with a permanent Secretariat in London. This body meets monthly and through its Sub-Committees is concerned to see that all available information on industrial processes using gas for heating is distributed throughout the Industry and the Trade and Technical Press where possible.

Further, by fostering the development and design of equipment, ancillary controls and devices and laying down standards for their installation and operation, the Committee has succeeded in raising the standard of performance of industrial gas equipment. In this, it collaborates very closely with the manufacturers of plant and, incidentally, with consumers. A close link has thus been forged between the important parties, the manufacturer of equipment, the manufacturer of goods (the consumer), and the Industrial Gas Engineer. In this, personal relationships have proved to be of the utmost value in maintaining and extending the load.

Because of the other close link which has now been forged between industrail Gas Engineers of the various Boards through the Committee, every consumer has at his disposal the advice and resources of all the Boards in a solution of a problem. If, for instance, a works in any area in the South of England has a problem requiring the use of gas for processing and the local Industrial Gas Engineer has not experience of the particular process, by a request for information through the Committee, an Industrial Gas Engineer, say in the North of England may be able to give details of a similar installation in his own area, provided always that such information can be released.

It will be appreciated that many processes are confidential to works' managements and cannot be divulged. Nevertheless, certain techniques involving design or type of plant can, in many cases, be passed on to be of material benefit to all concerned.

The moral behind all this is to get the consumer to consult his local Industrial Gas Engineer, Undertaking or Board, or a reputable firm of equipment manufacturers if he requires any advice on the use of gas for industrial processes. This will enable the best equipment possible to be suggested for the required operation.

Typical examples of the service that can be rendered to Industry have recently been given by Howell[18].

6. Summing up

An attempt has been made to show some of the developments in progress in the utilization of gas in industry. The demands of Industry for a heat service are growing and changing rapidly and it is essential for the Gas Industry to be able to meet and where possible, anticipate these demands.

Pictorial representation of the subject is not necessarily the best method, but in view of the wide field covered, this method was decided upon. Any further information, however, on the subjects discussed, or on the large number of activities not mentioned, in which gas features, can always be made available.

There can be no doubt that the Gas Industry has a great future part to play in giving clean, efficient and continuous Service to Industry.

7. Acknowledgements

Grateful acknowledgement is made to the manufacturers and organizations who gave details of the installations, and in particular, to those whose plant is reproduced herewith as a representative selection and who are mentioned below.

Baker Perkins Ltd., F. J. Ballard & Co. Ltd., Cochran & Co., Annan Ltd., Thomas Collins & Co. Ltd., The Dowson & Mason Gas Plant Co. Ltd., Gibbons Bros. Ltd., The Incandescent Heat Co. Ltd., Parkinson and Cowan Industrial Products, Radiant Heating Ltd., Stein and Atkinson Ltd., Surfard Ltd., Thermic Equipment and Engineering Co. Ltd., T. and T. Vicars Ltd., North Eastern Gas Board, North Thames Gas Board, Northern Gas Board.

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Fig. V	Tredegar Industrial Provident Society Ltd., Tredegar.
Fig. VI	Henry Lamb, Kensington, London.
Fig. VII	MacFarlane Lang & Co. Ltd., Osterley, Middlesex.
Fig. VIII	Ford Motor Co. Ltd., Dagenham, Essex.
Fig. IX	Motherwell Bridge & Engineering Co. Ltd.
Fig. X	Willson Lathes Ltd., Halifax.
Fig. XI	Gregg & Co. (Knottingley) Ltd., Yorkshire.
Fig. XII	Standard Telephones & Cables Ltd., Sidcup.
Fig. XIII	Electronic Tubes Ltd., High Wycombe, Buckinghamshire.
Fig. XV	Humber Canister Co., Hull.
Fig. XVII	Jefferson Smurfit & Sons Ltd., Dublin.
Fig. XVIII	Kings College University of Durham.
Fig. XIX	Kings College University of Durham.
Fig. XX	Peter Keevil & Sons Ltd., Edgware Road, London.

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(2) Electricity

by

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During the last fifty years electric power has transformed the industrial face of Britain. It was just at the beginning of the century when the first Electric Power Companies were being formed that the attention of all the electricity supply undertakings of those days was turned to the development of the use of electricity for industrial power purposes.

The need to develop the use of electricity for power in addition to lighting, its sole use at that time, was primarily economic. As Col. R. E. Crompton, one of the most noted founders of the electrical industry, said in his Presidential Address to the Institution of Electrical Engineers in 1895, "This process which we call the improvement of the load factor is a matter of such importance to you all that I need not apologise for dealing with it at some length. We not only desire to have the output of the generating stations more evenly distributed over the 24 hour day so as to fill up the valleys and reduce the peaks of our daily diagram but we also wish to improve the summer diagram as compared with the winter one."

The development of the electric power load since those days is now a matter of history and it is common knowledge that the pall of smoke which formerly hung over dense industrial districts has been very largely abated by the use of electric power in place of steam. During the course of this development the efficiency of electric power stations has been greatly increased and the cost per unit substantially reduced as indicated in Fig. 1

When the increased consumption of electricity is plotted, as in Fig. 2, against the industrial consumption of coal there is a graphical illustration of the extent to which the country has benefited from the development of electricity from the smoke abatement as well as other points of view.

As to the financial benefit to industrial consumers the following table shows that the electricity bill forms a very small percentage of production costs in practically all classes of manufacture. For instance, taking an average price of 1d. per unit, which is distinctly more than the usual rate for large factories, the cost of electricity expressed as a percentage of the value of the product is about 4½ per cent. in the case of metal manufacture and less than 3 per cent. for all other industries, the cost in most cases being in the region of only 1 per cent. or say 2d. in the £1.

TABLE 1.—Electricity Consumption and Output—Estimates for 1950

Industrial Groups	Units per £1 worth of product
Metal manufacture	11.3
Engineering, shipbuilding and vehicles	2.3
Other metal goods	2.3
Chemicals and allied trades	7.5
Textiles, clothing and leather	1.3
Food, drink and tobacco	0.8
Paper, printing, etc.	4.0

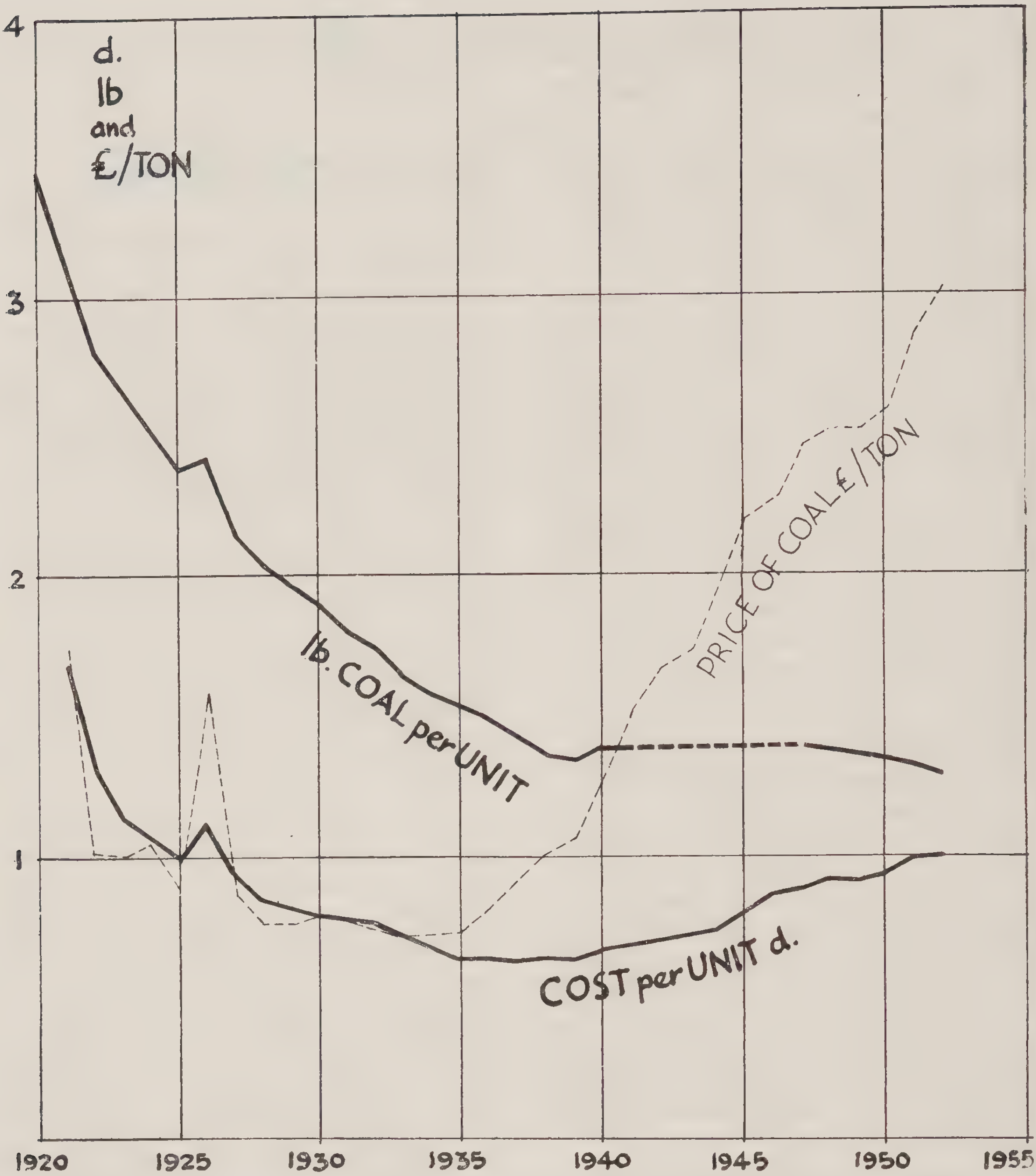

FIG. 1.—Reduced Fuel Consumption of electric power stations and Cost of Electricity supplied for industrial purposes 1920-52. (Rise in price of coal has more than offset reduced fuel consumption since 1939). Source: the Electricity Commissioners' Annual Returns and the Annual Reports of the British Electricity Authority.

The fundamental reason why it has been possible to supply electricity to industry at such low cost is because electric power stations, cables, switch-gear and other equipment inherently have a high capital cost in proportion to their running cost and the only way to supply electricity at the lowest possible price is to ensure that the power station, mains and equipment is used at different times of the day for different purposes. The supply of electricity for all kinds of domestic purposes in the home has been developed to a considerable extent in this country, though not so much as in North America, but factories and works still account for the largest consumption. To quote figures, the electricity supplied from the public mains to industry in 1952/53

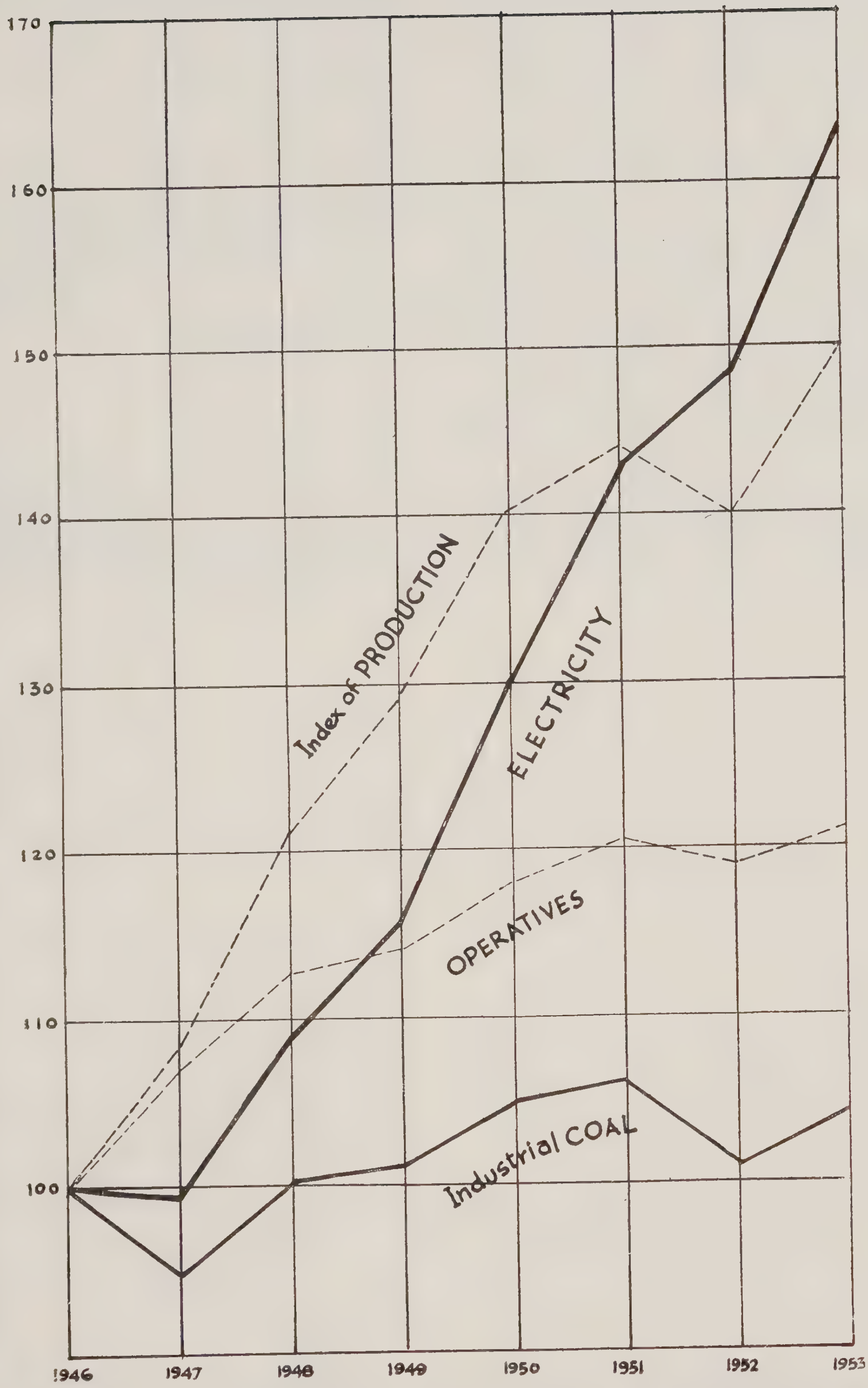

FIG. 2.—Industrial Use of Electricity and raw Coal 1946-53. The Index of Production and number of Operatives employed in industry are also shown, 1946 figures being taken as 100 in each case. Source: Ministry of Fuel and Power Statistical Digest and Annual Abstract of Statistics, Central Statistical Office.

was 26,000 million units, representing just over 50 per cent. of the total output; the revenue was approximately 41 per cent. of the total.

The Need for Increased Productivity

The greatly increased use of electricity in industry sometimes prompts the query, why use more? To begin to answer this question we must look at the whole picture of industrial production not only in this country but in the world at large. Since man is distinguished from the animals by his ability to reason and use tools, the more tools he can use the higher is his standard of living. The more mechanized an industrial process can be made the more plentiful is the product for a given amount of labour or, to put it in a word, the higher the productivity. The reason why the highest possible productivity is essential if we are to maintain our standard of living is, of course, because this country can only pay for imports of food and the raw materials required for our industries if we manufacture a sufficient quantity of goods at the right prices to enable us to sell a substantial proportion in foreign markets. In those markets we now have to compete not only with the most highly industrialized countries of the world but also with goods manufactured in other countries which formerly produced only primary commodities but are now anxious to foster local industries.

Here it is pertinent to quote the following table which appeared on the British Productivity Council's stand at the Production for Plenty Exhibition held in London in July, 1954.

In order to increase productivity our factories have to instal more and more labour saving machinery and to use every possible mechanical aid to speed up production and cut down rejects. One of the most commonly quoted criteria of progress in this direction is the amount of horsepower at the worker's elbow. The latest estimate* states that the average American worker produces between two and three times as much as the British and that the average American worker now operates about 8 h.p. as compared with about 3½ h.p. available on the average to the British operative.

The difference between these horsepower figures in the two countries is sometimes difficult to understand, especially when thinking of some of the most up-to-date factories in this country which are at least as well equipped as any on the other side of the Atlantic. The difference does not mean that any particular machine is driven in the U.S.A. by motors of twice the horsepower; the chief reason is probably that in America where markets are larger there is greater scope for mass production and so the average operative looks after a bigger machine requiring more horsepower to drive it. Alternatively, because both management and labour are more "production conscious" in the States, each operative may look after more machines. Whatever the reason for the difference, the conclusion can be safely drawn that the tendency is for British industry to use more and more power. To take only one example, the iron and steel industry used some 2,500 units for each operative in 1930 but the present day annual figure is six times as great.

TABLE II. PRODUCTIVITY=PROSPERITY

Output per person in industry		Income per head (£ Sterling)	
U.S.A.	250	U.S.A.	470
Canada	165	Canada	320
BRITAIN	100	BRITAIN	270
Netherlands	85	Netherlands	175
West Germany	81	West Germany	170
Japan	34	Japan	60

* "Why Productivity" British Productivity Council pamphlet.

IG. 3.—Drafting Room lighted by continuous troughs of fluorescent lamps giving shadowless illumination.

The modern uses of electricity in ndustry are far too numerous to menion in detail but it is hoped the ollowing outline of what is being done t present and possibilities for the uture will be of interest from the moke abatement point of view.

ighting

From being regarded as a substitute or daylight, often an inferior subtitute, lighting is now thought of as a production tool which can help to ncrease productivity. Seeing involves not only impressing upon the retina he picture which is presented to our eyes but also an interpretation of that picture to our brain, therefore the better the lighting the finer the detail and the shorter the time required for nterpretation. The practical value of better lighting can be shown by a simple experiment such as a gramophone turntable marked with some distinctive pattern and rotated at a constant speed. As the illumination is ncreased the pattern will be seen more clearly and the revolving table will appear to turn more slowly; the speed has not altered but we are seeing faster.

Good visibility, however, requires more than an increase in the amount of light; the quality of the light must also be improved and this is one of the reasons why fluorescent lamps are now so often used. Because their source of light is a long tube instead of a concentrated filament, fluorescent lamps are much less glaring, therefore they give better visibility as well as a saving in current.

The results of many carefully controlled experiments have shown beyond doubt that appreciable increases in production can be obtained by improved lighting, the figures ranging from 5 per cent. for rough work up to 25 per cent. increase in production for fine work like type setting—see Table III. Another significant reason for the employment of better lighting is a decrease in accident rate which of course also increases output.

A well-planned artificial lighting installation makes a factory more or less independent of daylighting, in fact in the U.S.A. many factories have been built without windows in order that the plant can be laid out regardless of daylighting, so making the best use of the floor space and reducing the effect of

TABLE III.—Increased Production with Improved Lighting

Type of Work Done	Illumination: Original Foot-candles	Illumination: Improved Foot-candles	Increase in Production
Woodworking	2.5	8	25%
Weaving (Rayon)	4-11	25	13%
Fine Micrometer work ..	3	10	10%
Thread Winding and finishing	3.5	15	10%
Machine Sewing and Setting Out Tables	low and very uneven	15-20	25%
Tile Pressing (rough work) ..	0.6	6	10%
Typesetting by hand ..	1.3	20	24%

weather conditions upon the interior temperature.

The last but by no means the least consideration influencing the adoption of better lighting is its psychological effect. Bright cheerful surroundings undoubtedly play a part in stimulating productivity both by their effect on the feeling of well-being of the operative and by their influence in reducing absenteeism. Some evidence of this was afforded when better lighting was installed throughout one large factory and the number of aspirins bought at the canteen dropped from 1,000 to 600 tablets a month.

Power

The economy, simplicity and adaptability of the electric motor has led to its widespread use in industry for every kind of application extending from a single motor developing thousands of horsepower for driving a rolling mill down to the tiny fractional horsepower motor in a portable drill, tens of thousands of which are sold every year to improve on muscle power.

At one time all production machinery had to be designed to be driven by belts or shafts from an engine and it is only within comparatively recent times that machine designers have come to make the most of the flexibility of the electric motor which in its simplest form has only one moving part and that virtually indestructible. Machine tools and other machinery in which several different motions have to be provided are now designed with a number of separate motors because it has been found that higher production rates are more easily obtained in this

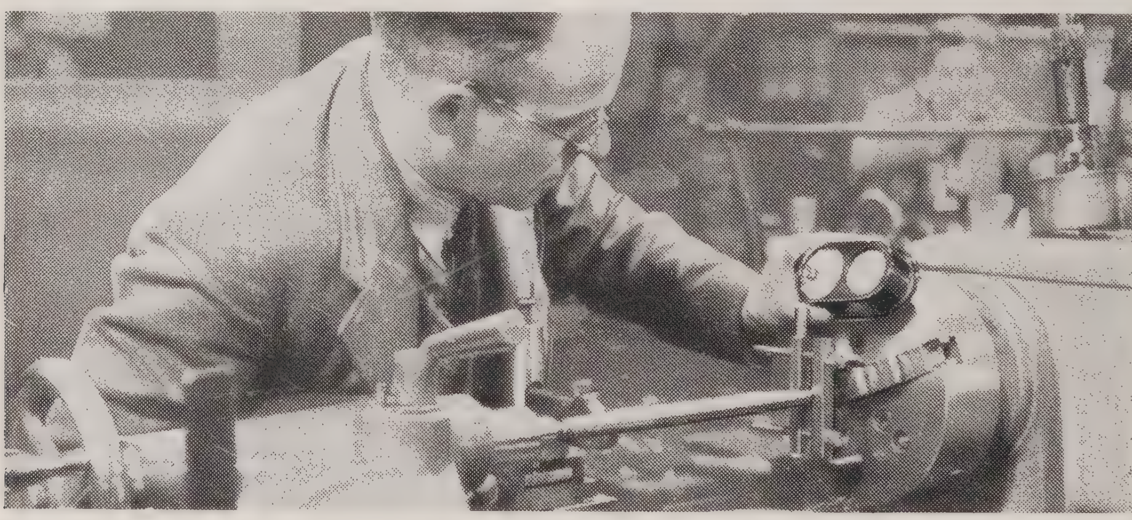

FIG. 4.—The illumination of any working position can be measured exactly by a portable lightmeter.

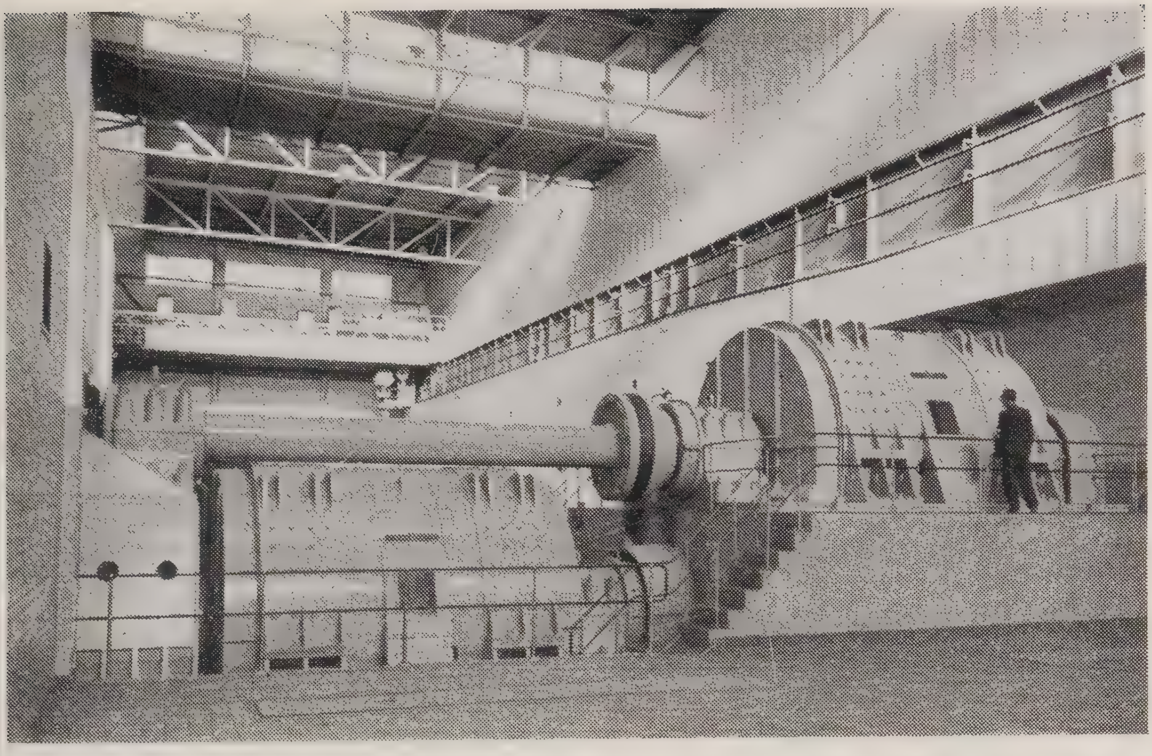

FIG. 5.—The Slabbing Mill at the Abbey Works of the Steel Company of Wales, rolls 20 ton ignots and is driven by two 4,000 h.p. motors designed for a combined peak load of 27,000 h.p.

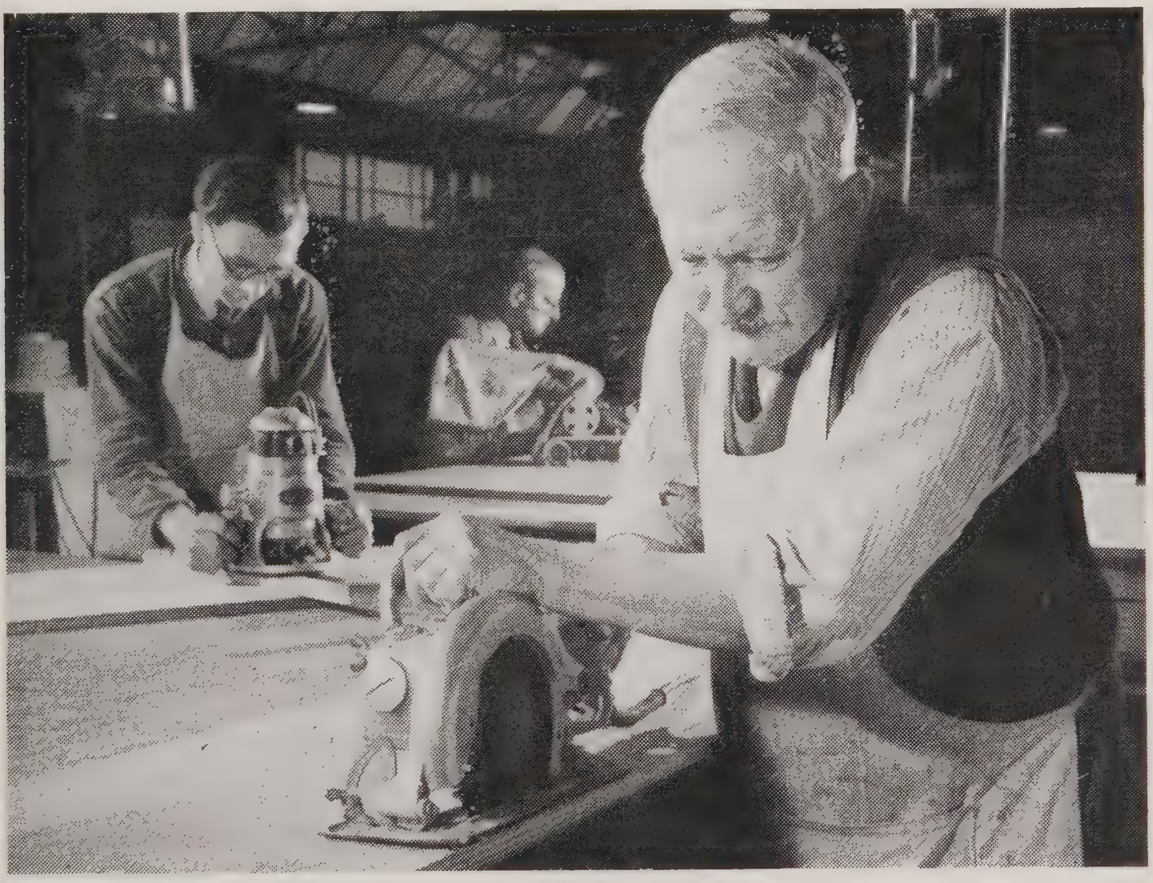

FIG. 6.—Portable electric tools enable work to be done more quickly with much less fatigue.

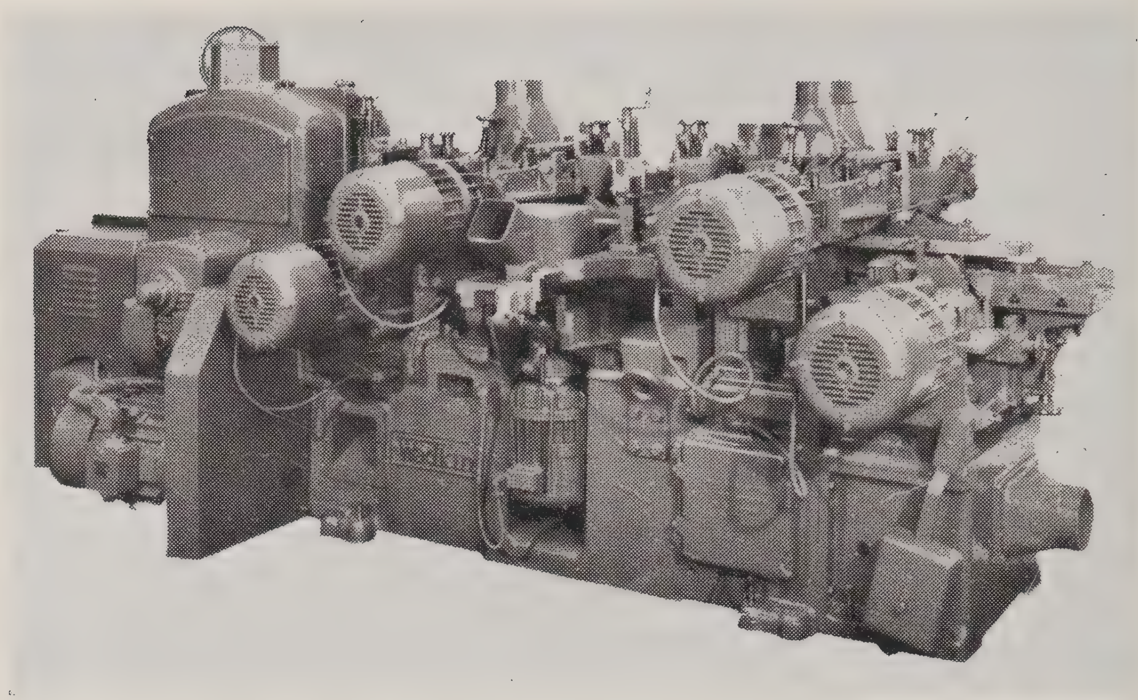

FIG. 7.—Rear view of a wood working machine with six direct motorised cutter heads, each motor being of 6 h.p. and running at 4,500 or 6,000 r.p.m. from a frequency changer built into the left-hand end of the machine.

way than by using complicated mechanical transmissions.

In other cases, particularly for driving high speed spindles, stator and rotor units are supplied by the motor manufacturer to the machine tool maker who then clamps the stator unit in his machine frame and mounts the rotor directly on the spindle to be driven.

An interesting example of individual drive occurs in the manufacture of rayon, where the filaments of cellulose pass into a spinning box driven at high speed by a specially designed electric motor. Mechanical drives have never been found satisfactory for this application and motors operating at speeds as high as 8,000 revolutions per minute have been used successfully for many years.

Individual electric drives, in effect, replace the transmission of mechanical energy through shafts, gears and belts which waste power, take up space and obstruct light, by the clean, efficient and unobtrusive electric cable transmitting energy to the point of use where the power is developed by the electric motor embodied in the machine. With electric drive the factory gives the impression of ordered efficiency where machine layout is

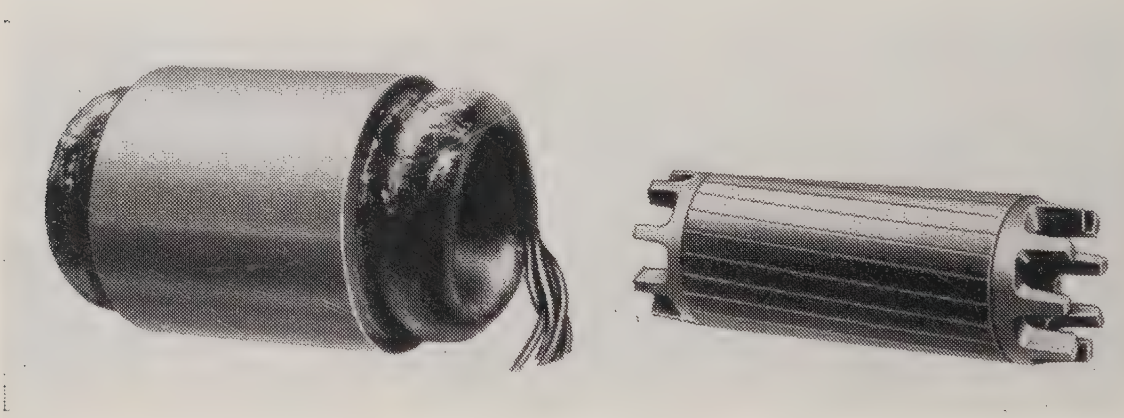

FIG. 8.—Typical stator and rotor units for building into machine tools and other machinery.

planned from a production point of view and operatives can see, move and work in easy freedom.

One of the most striking examples of multi-motored machines designed to increase productivity is the automatic transfer machine, see Fig. 9, as developed for the automobile and similar engineering industries to carry out a number of machining operations in sequence in one machine instead of a number of separate drilling, boring and milling machines on which the work pieces have to be set up by hand. A typical example of a transfer machine is one designed for machining gear box casings which replaces 18 unlinked machines, floor space being reduced from 1,800 sq. ft. to 885 sq. ft., machining is carried out at 28 stations in 93 seconds and the number of operatives required reduced from 13 to 3.

Control

The increase in the use of electric power in industry would not have been so great if precise and reliable methods of control had not been developed in step with the design of motors. For machines which are started by hand the convenient push button, which merely requires the touch of a finger to operate contactors (electrically operated switches) to close the starting circuits, has become very widely used, one of its advantages for large or complicated machines being the fact that "stop" buttons can be multiplied and mounted where they are handy to the working positions.

For automatic control of motors there is a wide variety of methods that can be used ranging from simple means like timing devices to complex servo-mechanisms. No matter what the characteristic of a process may be that governs the demand for power, whether it be the filling of a hopper or the temperature of a liquid or any other physical characteristic, the motors can be run automatically as required. In fact whenever the starting or stopping of a motor has to be carried out frequently as a matter of routine, the human element should be dispensed with and automatic operation employed. For example for the new blast furnaces of the Steel Company of Wales, the skip hoist charger, taking some 200 h.p., is operated entirely automatically; the operator has only

FIG. 9.—Automatic transfer machine at the works of the Austin Motor Co. Ltd. designed for machining the cylinder head of the A.30 engine.

FIG. 10.—The skip hoist charger installed for each of the new blast furnaces of the Steel Company of Wales at Margam is operated by a 200 h.p. motor which is automatically controlled.

to press one button to initiate the charging operation which covers loading the skip with ore, limestone or coke from bunker or scale car, hoisting and then charging the furnace through upper and lower bells, involving in all some 500 automatic operations of the control gear.

Other more complex types of control are used to increase productivity because they enable a process to be carried out automatically with greater accuracy than the most skilled operator. In order to obtain the highest degree of precision and the fastest speed of control, electronic methods

are coming more and more into use in industry. By means of various kinds of valves, the smallest not very different from those used in a domestic radio receiver, motors up to the largest sizes are controlled with an accuracy that is almost unbelievable. For instance, the flying shear that is used in a steel works to cut off required lengths of hot strip as it emerges from the mill at a speed of 1,000 feet per minute or more, is operated automatically with an error of no more than a quarter of an inch in a length of say 20 feet.

The intensive development which took place during the war in systems of gun-laying and radar control led to great advances in the design of servo-mechanisms or closed-loop controllers in which some indication or signal of what is happening at the output end is transmitted back to the controlling end. In this way any errors which might occur owing to imperfections of design, effect of temperature or similar factors are automatically corrected and highly accurate control obtained. An industrial example of a process controller used to perform a task which would be impracticable by hand is the electronic control of the auto-profiling machine shown in Fig. 11. One of the latest designs of process controller depends on a radio-active isotope emitting beta rays which are used to gauge the thickness of a material being manufactured, for example aluminium foil, as it leaves the rollers. The source of radiation is placed above or below the material and an ionisation chamber on the other side; the radiation falling on the chamber is reduced according to the weight per unit area or thickness of the material and the ionisation current therefore gives an accurate measure of the weight or thickness. This very minute current is fed into an electronic amplifier, the output of which controls the setting of the rolls and so the thickness of the foil.

Heating

The use of electricity for heating purposes is second only in importance to electric power in industry. The use of electricity, a high grade form of energy, for heating purposes may seem at first sight to be either wasteful or expensive. The fact that electricity is a high grade form of energy however, gives the clue to its successful employ-

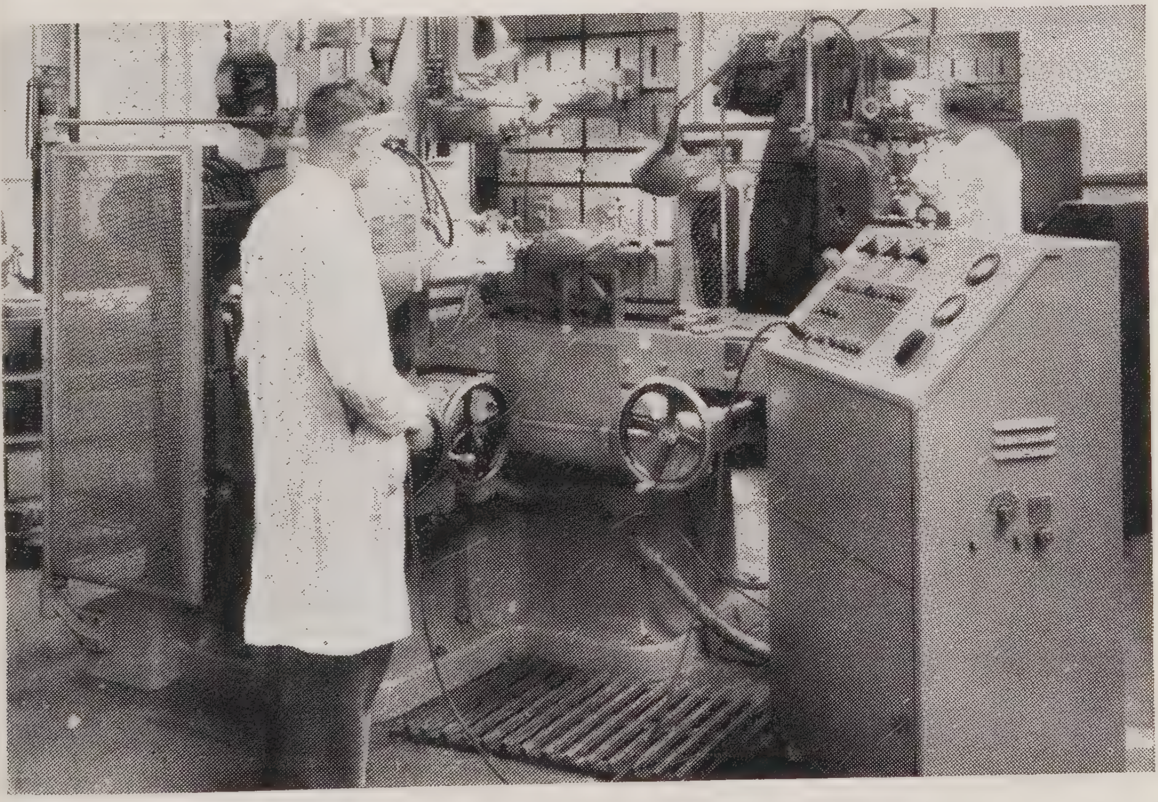

FIG. 11.—Electronically controlled Auto-Profiling machine.

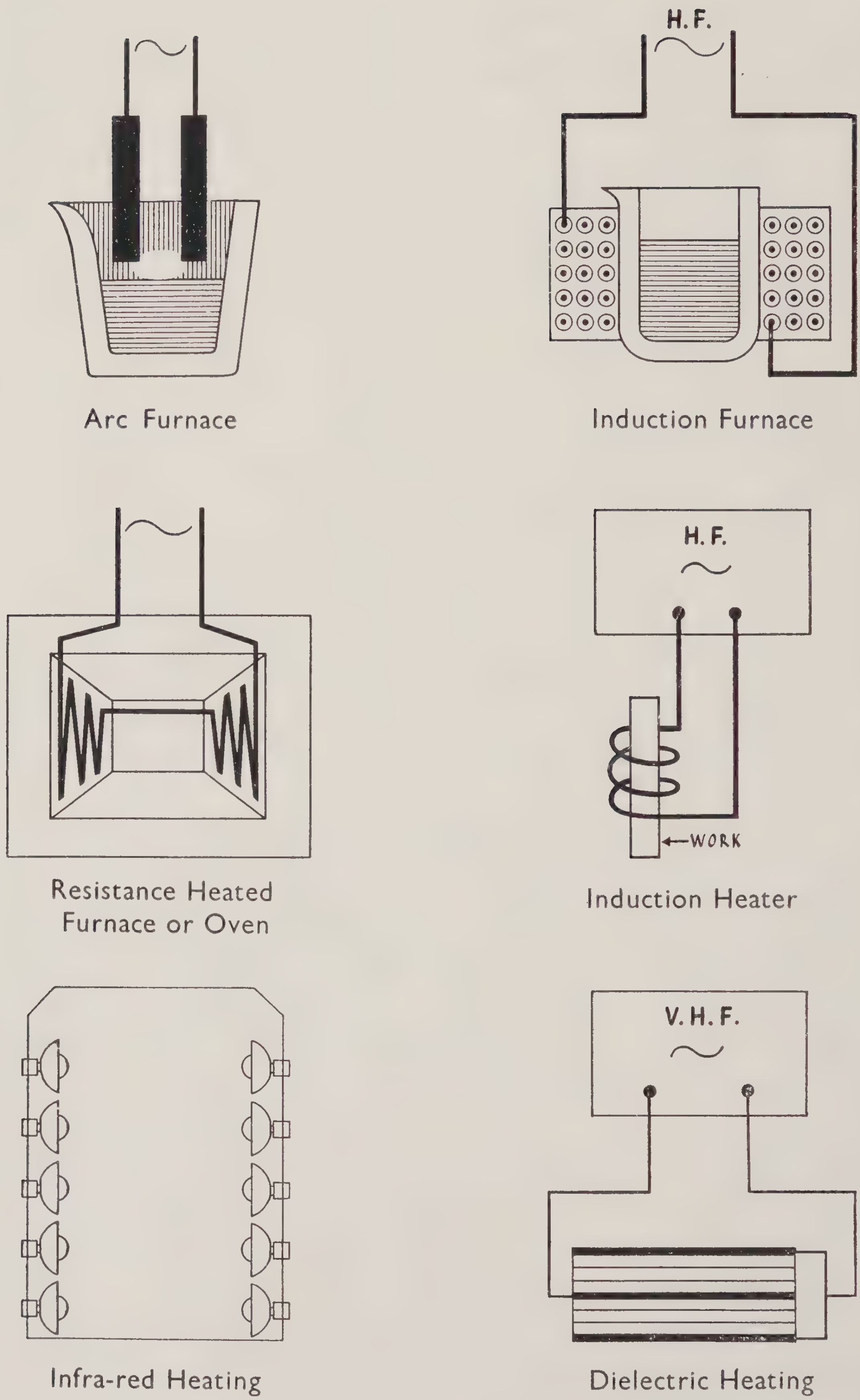

FIG. 12.—Diagrammatic representation of the principal methods of electric heating.

ment for many diverse industrial heating processes ranging, for example, from a small soldering iron, with all the heat concentrated where it is wanted, to a furnace for melting metals at temperatures up to 3,000° C.

As a broad statement it is true to say that the chief reason for using electricity as a source of heat is to increase productivity. Productivity is increased in a variety of ways but generally by:

(*a*) The production of materials or quality of material which cannot be produced by other forms of heating.

(*b*) The reduction in number of rejects.

(*c*) The saving of labour.

(*d*) Greater speed of operation.

(*e*) Heat treatment can often be carried out in the production line to reduce handling.

(*f*) Improved working conditions.

Many examples might be given ranging from the production of special steels and alloys which can only be made (because of their composition or precise heat treatment) in an electric furnace, to a small induction heater operated by unskilled labour for the case hardening, according to an automatic time cycle, of injection pump plungers which have to be held to very close tolerances in their dimensions and hardness.

Moreover electric heating is not confined to the metal-working industries. It is used extensively in the plastics industry for pre-heating, forming and joining, in the pottery industry (the new Wedgwood works built in a country district was designed as an all-electric factory to provide good working conditions for nearly 1,000 people) and in the woodworking trades where electric heating is revolutionizing methods of manufacture.

There are many reasons why electricity is the ideal method of heating; with electricity the exact quantity of heat necessary to give the required temperature can be readily obtained and this temperature held constant for any length of time; thus results can be repeated with certainty. Variations in calorific value of the heat source are impossible because the heat content in a unit of electricity is an unalterable physical quantity and this greatly simplifies both the design and operation of all electric heat treatment plant. There is no combustion, therefore no regulation of air supply is required.

Electric heat is clean and free from the products of combustion present in fuel-fired furnaces; no chimney or flues are required and there is much less in the way of foundations and space occupied. Regulation of heat is simple and positive so that thermostatic control is more reliable and exact than with any other method of heating. Electric heat is readily adaptable to all process requirements, heating elements can be of any size and shape most suitable from a production point of view and they can be distributed so that the temperature is absolutely uniform, a condition unattainable by other methods.

Electric heat improves working conditions, there is an absence of dust and fumes and the outside of an electric furnace or oven remains cool and, being a self-contained unit, it can be placed in the production line.

Owing to absence of flame there is less wear and tear of furnace brickwork; electrically heated furnaces and other equipment require a minimum amount of maintenance and repairs. Electrically heated equipment can be started automatically by time switch so that it is up to working temperature first thing in the morning.

The transformation of electrical energy into heat by passing a current through a heating (resistance) element is familiar to everyone who has seen a domestic electric fire. This resistance method of heating is widely used in industry but it is by no means the only method as Fig. 12 shows and this enables the most suitable and efficient method to be chosen for any particular application.

Arc Furnaces.—The electric arc produced between carbon electrodes is well established for steel making, (a typical furnace is shown in Fig. 13) the

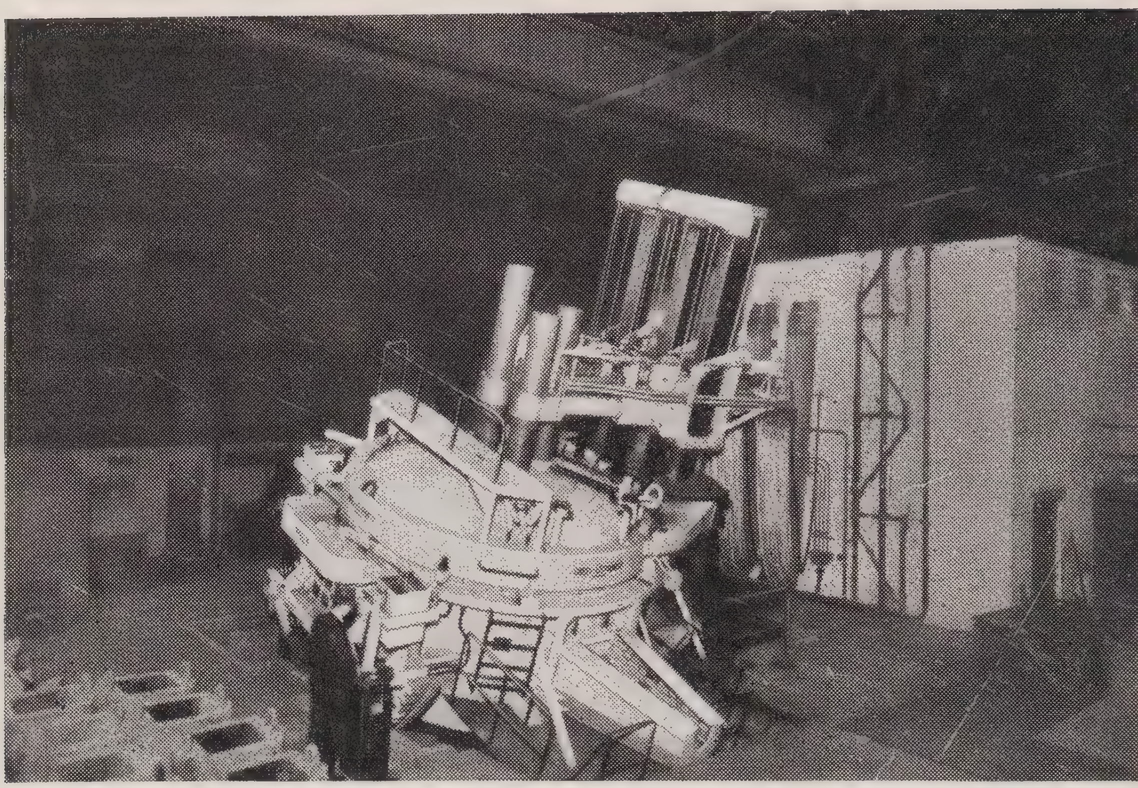

FIG. 13.—Steel melting arc furnace of 20 tons capacity shown partly tilted.

annual output of electric steel being upwards of half a million tons. The arc is particularly suitable for melting scrap and for refining so that a large proportion of the production of special steels is made electrically.

Until recently a similar state of affairs existed in the U.S.A. but over there electric furnaces are beginning to be used instead of open hearth furnaces for making plain carbon steel. A recent report prepared by the Battelle Memorial Institute and published last year under the title of "Comparative Economics of Open Hearth and Electric Furnaces for the production of Low Carbon Steel," shows that this tendency is sound financially and from a fuel-saving point of view. The conclusions reached by the report are that the capital outlay required for an electric furnace shop with an annual capacity of 250,000 tons is little more than half that required for an open hearth furnace shop and the net production cost shows an advantage to the electric furnace of no less than 7 dollars a ton. This means an annual saving amounting to 25 per cent. of the capital involved.

Since the publication of the report the U.S.A. figures for 1953 show that electric furnace steel has passed the 8 million tons mark and that no less than 52 per cent. is straight carbon steel. Moreover it was forecast at the 1953 Annual Convention of the Association of Iron and Steel Engineers in Pittsburgh that within 25 years 30 per cent. of the total production of straight carbon steel would be made in electric furnaces.

Translating the U.S. costs into U.K. figures is complicated by the system of levies at present in force in this country to encourage the use of pig iron rather than scrap, but estimates have been made*, neglecting the levies, and the results are shown in Table IV.

In addition to the savings in capital and running costs it may be noted that electric steel melting saves fuel since each ton of steel produced in an arc furnace requires approximately 550 lbs. of low quality coal to be burned at

* "Economics of Steel Production," J. C. Howard, Electrical Review, 18th June, 1954

TABLE IV.—Comparison of estimated capital costs and production costs per ton of ingots for open-hearth and electric furnace shops—U.K. conditions, annual plant capacity 250,000 tons (cold charge).

	Open-Hearth Shop	Electric Furnace Shop
Capital cost	£2,900,000	£1,700,000
Metal cost	£9.5	£7.8
All other costs ..	£5.8	£6.0
Net production costs ..	£15.2	£13.7

the power station, whereas each ton of steel produced in the open hearth furnace needs the best part of 700 lbs. of high grade, low ash, coal to be burned in the producer gas plant.

There are also advantages from an operating point of view; an arc furnace is much more flexible, it can be readily shut down and re-started, it can run on a small charge or a single shift. Furthermore the improved working conditions should be mentioned, the operator always has close control of the process, there is plenty of scope for him to use his intelligence and produce a good melt.

Induction Furnace.—The next type of electric furnace shown in Fig. 12 is also used for metal melting, particularly for steel and non-ferrous alloys. For steel melting the furnace takes the form shown in the diagram where the melting crucible is surrounded by a coil carrying an alternating current with a frequency of 500-2,000 cycles per second. At this frequency powerful currents are induced in the metal charge which is soon melted and then becomes subject to a stirring action caused by the magnetic forces. By this method virtually all the heat is concentrated in the metal itself; none is wasted in combustion or chimney loss, in fact the outside of the furnace is quite cool.

For melting non-ferrous metals the induction principle is used in rather a different way; the charge, because it is non-magnetic, is arranged in the form of a short-circuited secondary loop, and with this method AC current of normal frequency (50 c.p.s.) can be employed. Again the heat is concentrated in the metal itself and the working efficiency is three or four times that obtained with externally-fired furnaces. But the advantage from a production point of view is the close control over the composition of the metal and it is primarily for this reason that over 90 per cent. of the high grade brass made in the U.K. is melted by electricity.

Resistance Furnaces.—The production of heat at any temperature up to about 1,200° C. being so simply carried out by passing a current through a resistance wire, electric resistance furnaces are made in a large variety of types. Fig. 14 shows the heating elements in a bell type furnace designed to be lowered on to the charge.

The principal types of furnace and some of their uses are as follows:

Batch Furnaces:

(*a*) Box. Usually rectangular section; for tempering, annealing carburizing, brazing.

(*b*) Pit. Circular or rectangular section, removable cover; for tempering, annealing, normalizing, carburizing.

(*c*) Car bottom or bogie hearth. Large box with bottom and hearth mounted on wheels; for annealing and tempering steel forgings, annealing castings, stress relieving welded structures.

(*d*) Portable cover or bell. Circular or rectangular section; for annealing steel strip, wire in coils and malleableizing.

(*e*) Elevator. Bottom and hearth loaded with charge and then raised into body; for annealing, malleableizing castings.

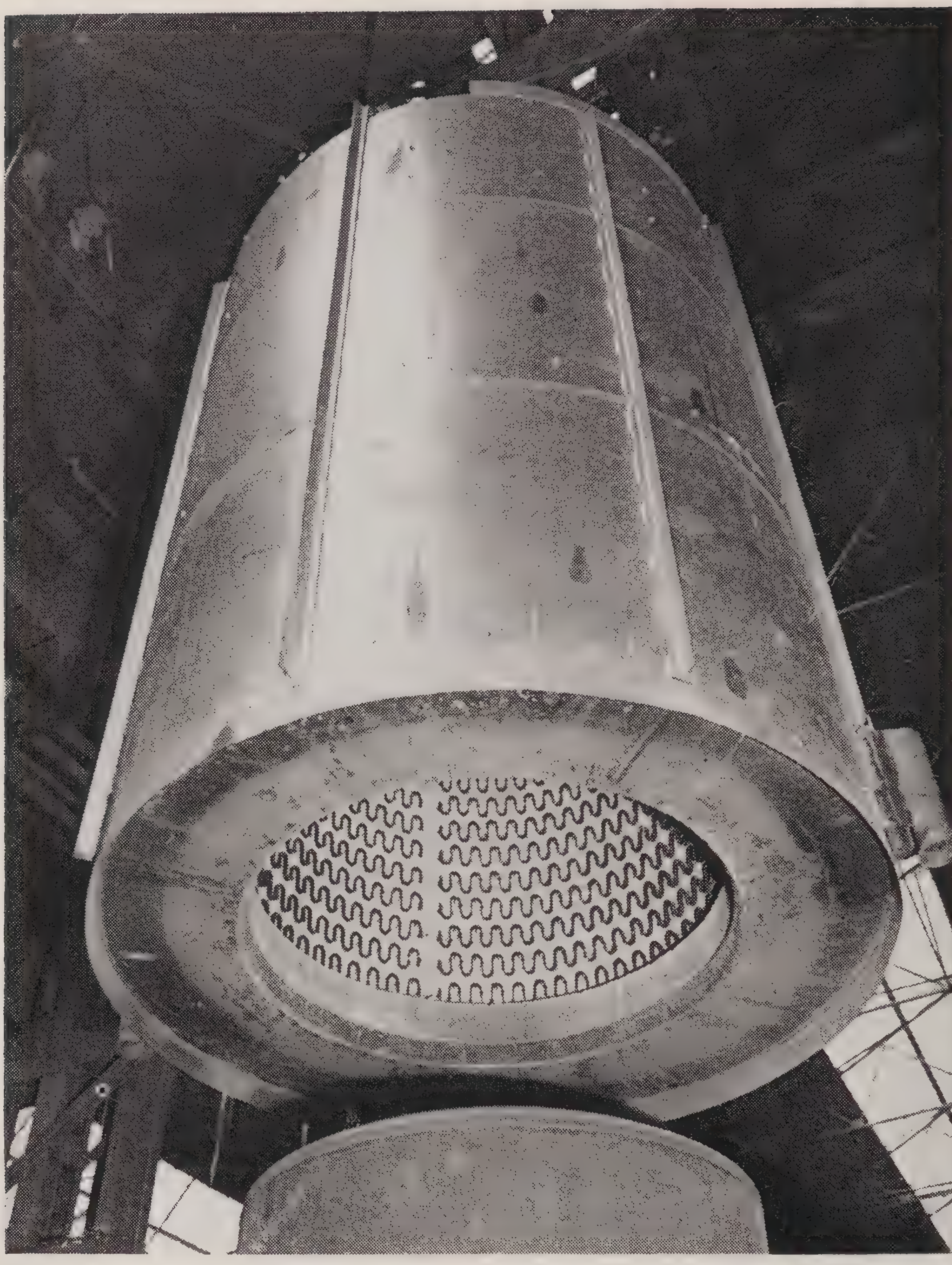

FIG. 14.—A vertical cylindrical bell furnace in the raised position showing heating elements. The furnace weighs 15 tons and is charged up to 20 tons, the electrical rating being 360 kW.

Continuous Furnaces:

(*a*) Inclined hearth. Charge rolled or pushed down inclined hearth; for heating steel billets and slabs.

(*b*) Rotary hearth. For heating gears, shells, copper billets.

(*c*) Pusher. Charge pushed one piece against another, or in trays, through furnace; for hardening and tempering, annealing castings and forgings.

(*d*) Roller hearth. Rollers driven by extensions through side walls; for brazing, bright annealing, normalizing, harden-

ing, tempering, annealing castings.

(*e*) Mesh belt conveyor. Woven heat-resisting wire belt; for brazing, annealing.

(*f*) Chain conveyor. Annealing, stress relieving of heavy parts.

(*g*) Shaker hearth. Reciprocating shaker motion conveys charges; hardening small parts.

(*h*) Walking beam. Reheating, annealing heavy castings.

(*i*) Rotary furnace. Spiral guides feed material through; for hardening small parts such as ball bearings.

The principal reasons leading to the choice of an electric furnace are precise temperature control—some aluminium alloys can only be heat treated successfully in an electric furnace—and the ease with which any controlled atmosphere required by the process can be produced in the furnace, for example the gaseous annealing of malleable castings. In this patented process the cumbersome boxes packed with iron ore are replaced by a decarburizing atmosphere with the result that operating times are reduced to a quarter and costs to a fraction of those incurred with the old method.

Resistance furnaces are used for vitreous enamelling and for pottery kilns although in the latter special types of element have to be used for the higher temperatures and the kiln is usually made in the form of a tunnel, see Fig. 15, through which the ware slowly travels; there are often twin tracks with the ware moving in the opposite directions so that the incoming charge is heated by the outgoing ware, thus improving the thermal efficiency. The important part in regard to productivity is that the quality of the final product is higher owing to the accuracy of control and the absence of sulphur, dirt and high temperatures. In addition the amount of labour required for supervision and repairs is very low. The number of electric kilns in use in the Potteries is now in the region of 150 and it is estimated that they have obviated the burning of over 100,000 tons of coal in the old fashioned bottle kilns.

FIG. 15.—Electric tunnel kiln for glost firing domestic ware.

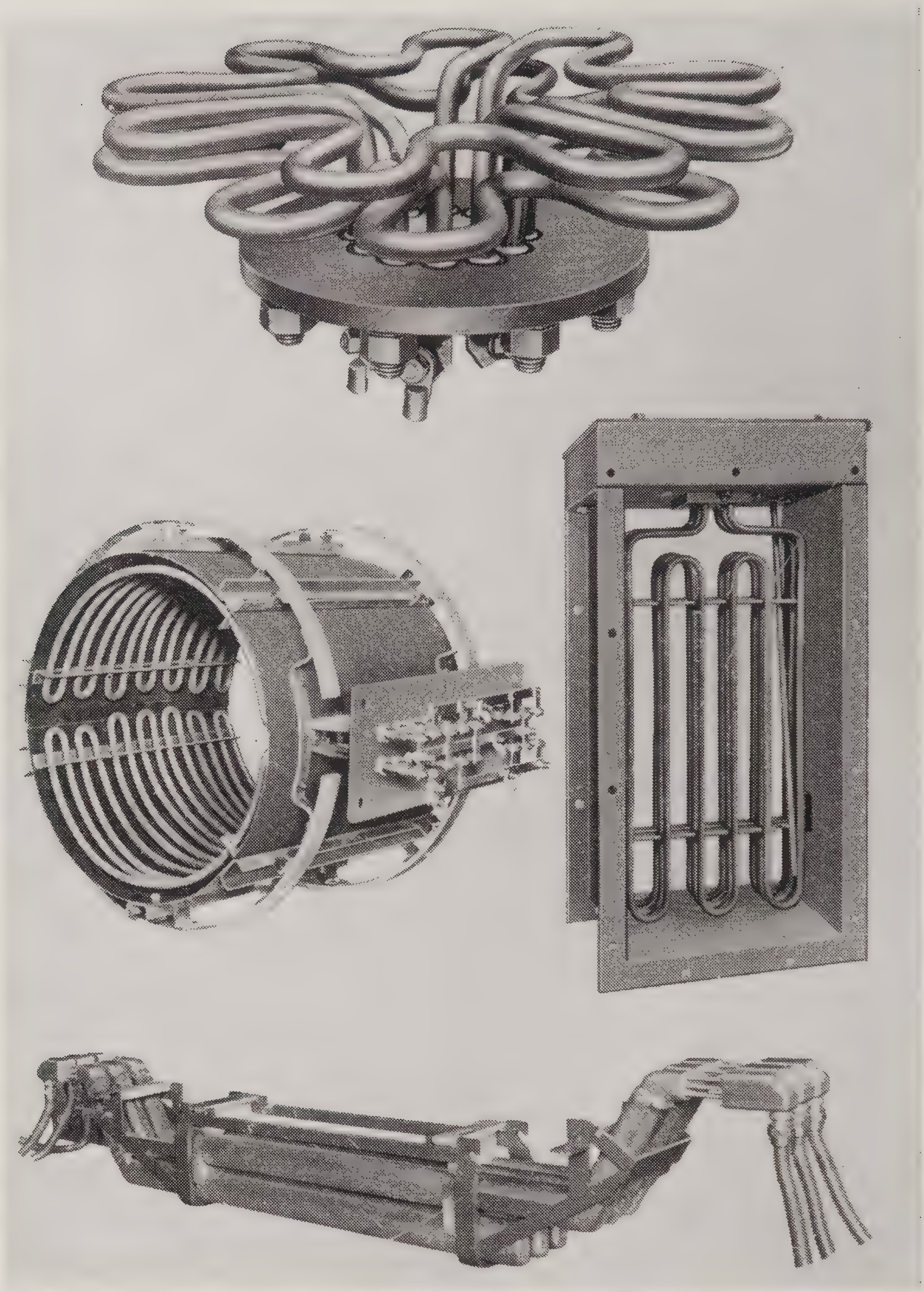

FIG. 16.—Various types of sheathed-wire heating elements. Top: Immersion heaters (18 kW.) for steam generator. Left centre: Heater for 800-ton extrusion press. Right centre: Air heater for forced convection installation. Bottom: Assembly of "cast-in" immersion heaters for tin-plating plant, the assembly weighs over 2 tons and has a total rating of 180 kW.

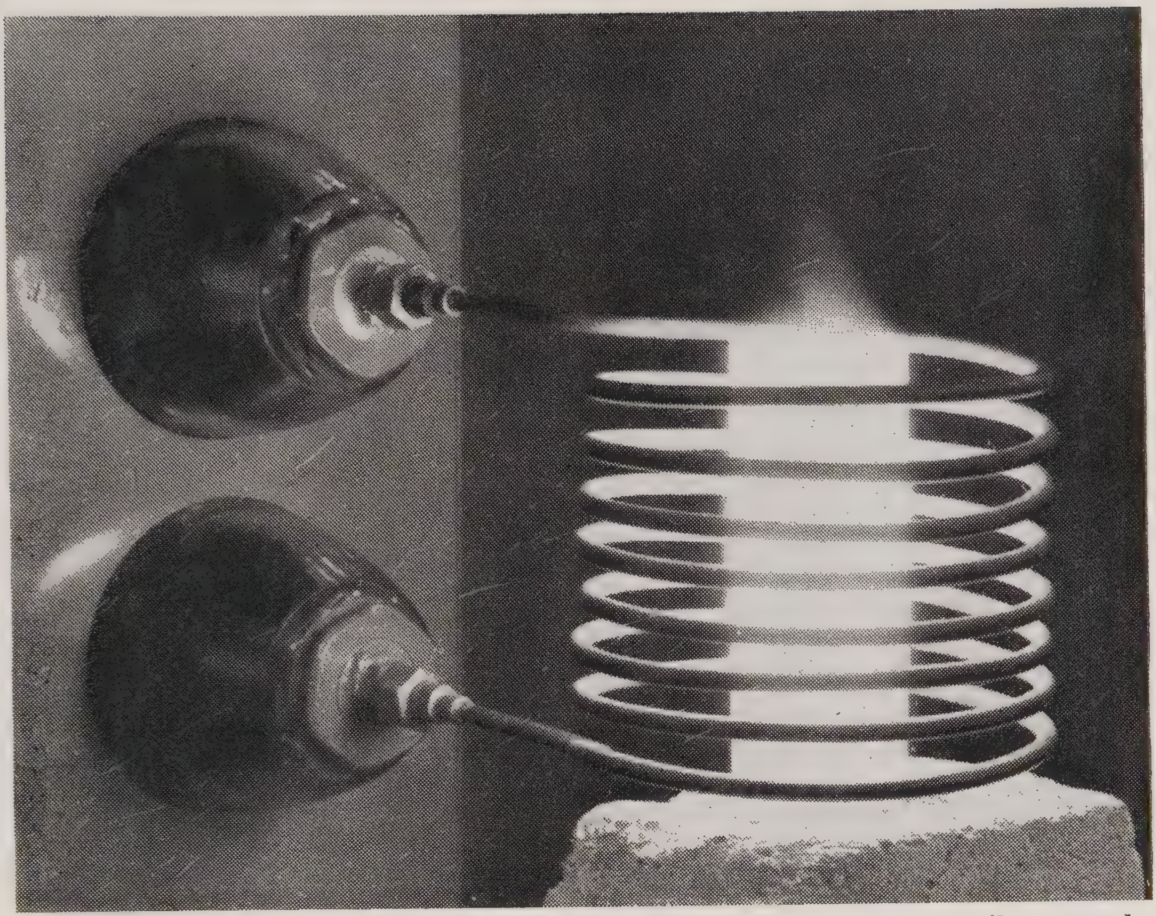

FIG. 17.—Demonstration of induction heating of steel. The applicator coil surrounds a small steel billet placed on a fire brick support; the steel has been heated to incandescence.

Apart from resistance heated furnaces and ovens there are many forms of resistance heating elements, see Fig. 16, which are made for fitting into almost any kind of process machinery or plant which needs a clean, convenient and compact method of heating. In addition there is a wide range of utensils of all kinds with built-in heating elements such as kettles, vats, glue pots and the like.

Induction heating.—The same principle as already described in connection with the induction furnace can be used for the electric heating of a number of processes, in fact wherever metal has to be heated quickly or locally.

A simple demonstration is shown in Fig. 17, where a steel billet is heated to any required temperature by means of a high frequency current flowing in the applicator coil surrounding it. In this way the metal can be heated throughout its thickness or alternatively, if it is required to heat only the skin of the metal, for example to produce a hardened case leaving a tough core, the heating effect can be confined to the surface layers by suitable choice of frequency and speed of heating. Induction hardening in this way can be made completely automatic by incorporating timers and automatic quenching so that the heater can be regarded as though it were a machine tool and heat treatment carried out in the line of production.

Induction heating is also applied to soldering, brazing and a number of other processes such as the heating of platens. One of the most successful large-scale applications of induction heating is in the large press-forge shop built by Messrs. Garrington Ltd. in 1948 at Bromsgrove which is regarded as the most up-to-date in Europe, if not in the world. This shop has been described as the "forge without a fire" and is housed in an immense glass-sided building covering 3½ acres. The interior is light, airy and clean com-

pared with conventional forges with open-hearth furnaces and toiling stampers carrying red-hot billets in tongs. The building is equipped with 12 forging presses of from 500 to 5,000 tons capacity. Next to each press, as shown in Fig. 18, is an electric induction heater fitted with a rotary hearth which takes the billets through the heating zone and automatically discharges them down a chute ready to be manipulated on the bed of the forging press. The induction heaters for the larger presses have a rating of 800kW. at 3,000 c.p.s. and are capable of heating billets 5 inches square at production rates of 4,800 lbs. an hour.

The main advantage of the induction method is the speed of heating, for example a $1\frac{1}{2}$ inch billet needs only 45 seconds, compared with 10 minutes in an ordinary furnace. In this short time no scale is formed and so the forgings can be made to closer tolerances, thus avoiding subsequent fettling.

Infra-red Heating.—Many processes for which slow heating and low maximum temperature always used to be employed have been shown to be equally well carried out at a higher temperature for a shorter time. The quicker treatment increases productivity, not only in the heating process itself, but also by enabling the heater to be fitted into the production line, so that handling is greatly reduced and the whole process made automatic. This speeding up applies more particularly to those processes involving a chemical change; in the drying of certain paints, for instance, it has been found that 3 minutes of 400° F. gives equally good results as 45 minutes at 250° F. For quick drying of painted surfaces and similar processes it is essential to apply the heat by radiation rather than by convection as in an oven. The first form of radiant heater to be used for this purpose consisted of a number of high power electric lamps

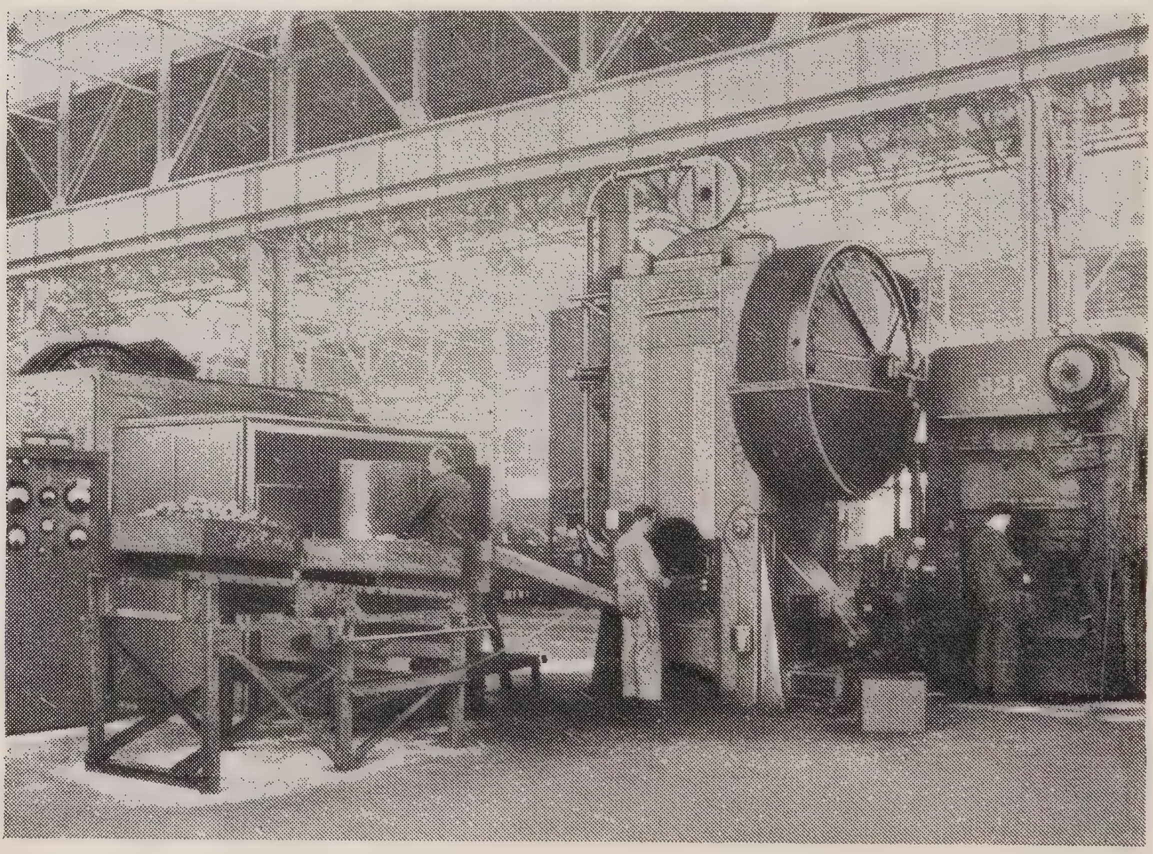

FIG. 18.—The induction heating of billets prior to forging. The illustration shows, left to right, the induction control panel, the induction heater with chute for conveying the hot billet to the forging press and on the right the stripping press.

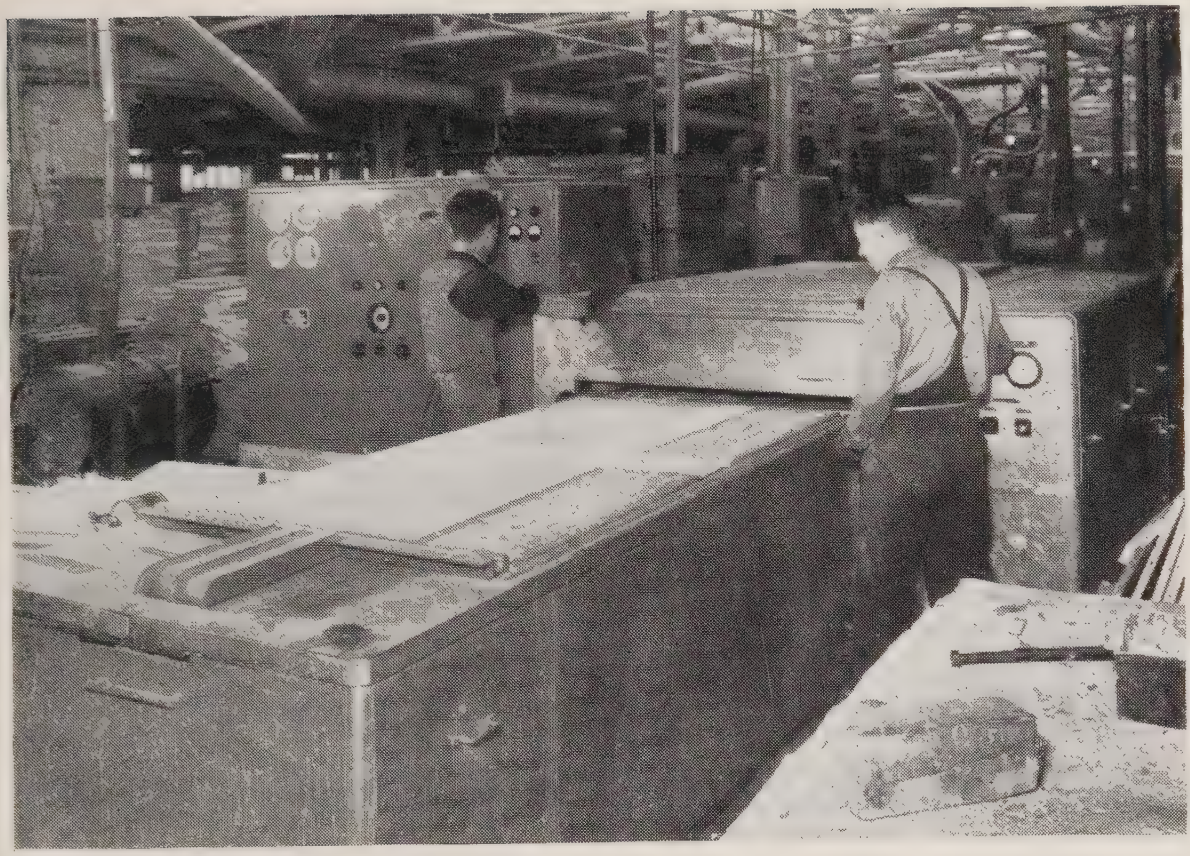

FIG. 19.—Radio frequency edge gluer used to make panels for furniture manufacture. Panels 46 inches long and $16\frac{1}{2}$ inches wide having seven glue lines can be produced more than three times as fast as the method formerly used.

operated at a temperature below that of ordinary lamps so as to give a greater output of radiation in the infra-red part of the spectrum. Subsequently sheathed-wire resistance elements run at a bright heat and mounted in concentrating reflectors have come to be used; they can, if necessary, be designed to impart a higher intensity of radiant heat as required by more massive articles.

One of the advantages of the electric infra-red oven is that when used to dry articles on an overhead conveyor it can be fixed high up so saving floor space and enabling the articles to be dried automatically according to the speed of the conveyor and the amount of heat in the oven.

Dielectric Heating.—Another relatively new method of electric heating is unique in that it affords a means of drying non-metallic materials much more rapidly than is possible in an oven or by any other method. The heating effect is produced by placing the material as a dielectric between two plates electrically charged at a high voltage and at a very high frequency equal to those used for radio transmission. Under such conditions a charging current flows through the insulating material and heats it internally in the middle as much as the outside. It is therefore possible to heat such materials, which are generally bad conductors of heat, much more quickly than by conventional methods of heating. Moreover by adjustment of frequency it is possible to heat some part of a composite material more quickly than the rest and this effect is used to good advantage in heating the synthetic glue which is now largely used in the manufacture of plywood, and in furniture making and other woodworking industries. A typical edge gluing press is illustrated in Fig. 19.

Other Manufacturing Processes and Methods

Although not perhaps of so much importance from the smoke abatement point of view there are many other uses of electricity in industry which

should be mentioned if only to indicate the wide variety of electrical means of increasing productivity.

In the metal working industries, welding, for example, has become a well established method of fabrication instead of casting or forging. The largest and most complicated structures can be made by welding together relatively thin steel sections in place of heavy castings.

In addition to arc welding, resistance welding has become highly developed especially in the mass production industries. In automobile manufacture, where the design of modern pressed steel bodies has only been made practical in thin gauge metal by the extensive use of electric welding, some multiple machines make no less than 250 welds simultaneously and welder ratings of 70 kVA or more are common values. Other developments of the resistance welder are for stud welding, rivet heating and upsetting.

A whole range of other electrical applications, many of them developed as a result of advances in electronics, deal with the testing and inspection of goods either in the finished state or in the course of manufacture. The chief advantage of the electrical method is that it is non-destructive and so it can, if necessary, be applied to the whole production and not merely to a few samples which may not be representative; in addition it is much more rapid and needs no special operating skill. Since almost all the physical properties of materials can be detected by one electrical means or another, the number of different types of apparatus that have been or could be devised are very great; some of the more common criteria are crack detection and composition of steel, dimensional measurements including thickness of surface finishes, strain measurement, metal detection, contents gauging, moisture and *p*H determination.

Among electronic tools for inspection the photo-electric cell is one of the most versatile, its uses varying from counting objects passing on a conveyor to detecting pin holes down to 1/1,000 inch diameter in tin plate strip travelling at 600 feet a minute.

Information in regard to the latest practice in the application of electricity to industry is always available from the Electricity Board or the British Electrical Development Association, 2 Savoy Hill, London, W.C.2.

Discussion

Dr. W. A. Macfarlane, Sessional Chairman, before the presentation of the papers, spoke as follows:

Your President, Sir Ernest Smith, and your Director, Mr. Arnold Marsh, have encouraged me to diverge from my duties as Chairman of this afternoon's session for a few minutes at the start, in order to speak briefly about the organization—the National Industrial Fuel Efficiency Service—of which I have been appointed Chief Executive. There have been so many kindly references earlier in this Conference to N.I.F.E.S.—from your President, from Sir Hugh Beaver and from other speakers that I feel we owe you some report on our progress, and some suggestions as to how we feel we may be able to forward the objectives of your society. It is evident that considerable hopes rest on the success of N.I.F.E.S. I can assure you that we shall do our best to see that those hopes are exceeded.

The National Industrial Fuel Efficiency Service, you will recall, was formed last December, on the recommendation of the Pilkington Committee, to take over and expand the work hitherto performed by the Ministry of Fuel and Power. It has been set up as an independent, non-profit making company to provide a service by industry to industry. With Sir Leslie Hollinghurst as Chairman we have a Board of Directors of men so well-known in industry that you can be assured of the independence of the organization and that its policies will

be shaped in such a way as to be responsive to the needs of the industrial consumer.

There has been so much news in the papers during the last week about the dangers of a fuel crisis that I need hardly go into the reasons why an expanded fuel efficiency service is necessary. But there is one aspect of those news stories that does worry me. There seems to have been too much emphasis on what the other fellow might have done to avert this difficulty—if only the N.C.B. had done this instead of that—if only the miners would work a "bullweek" every week—if only industrial production hadn't increased—if only the weather had been better. Yesterday this Conference agreed that, as domestic fuel consumers, they were all guilty of some contribution towards atmospheric pollution, and no doubt each one of us privately resolved to mend his ways. So with fuel efficiency. I feel that we must face the situation as it is—whatever may or may not be the causes—and make our own contribution to overcoming this difficulty.

Let us also be clear that the need for greater efficiency in the use of fuel is not one that will disappear when we have got through this winter. Sir Hugh Beaver advocated yesterday that a long view must be taken of curing atmospheric pollution, and so it is with fuel efficiency. The papers to be presented this afternoon show that very clearly. Mr. Bernard illustrates in his second figure how enormously rapidly the demands of industry for power are increasing. Mr. Hayman quotes a correspondingly rapid increase in the industrial use of gas.

These developments are greatly to be welcomed for, as the authors point out, they not only make possible that increase in the country's industrial productivity, which is essential if we are to survive, but they contribute substantially to a cleaner atmosphere and therefore to an improvement in the nation's health. If they are to go on, as they must, on a rising rate of industrial production, we shall continue to be faced with the problem of how to find the coal required to meet the nation's energy demands. Fuel efficiency, therefore, is not a question of how we are to get through the next few months, but one that will be with us for the foreseeable future. We must make our plans accordingly.

Meantime, let me give you an account of N.I.F.E.S. first few weeks of operation. In the belief that efficiency begins at home, we have set ourselves to streamline the service so that without in any way reducing the high technical standards that the Ministry's engineers—most of whom are now N.I.F.E.S. engineers—have set, more firms can get advice in a brief and practical form. You will all, I hope, have seen our brochure—*N.I.F.E.S. Four-Way Services*—which represents the results of this streamlining.

Thanks to a most friendly and helpful press, the response to this restatement of our services has been extremely good. Indeed, in some parts of the country we have already reached the position that we have made contracts for all the survey work the existing staff can provide for months ahead, and we are having to draft in additional engineers. Since your President and His Worship the Mayor decided yesterday to start the War of the Roses again, and unearthed an ancient hatchet, let me say that Lancashire and Yorkshire are battling for first place with N.I.F.E.S. too.

From this experience, an interesting conclusion is beginning to emerge, and one, I was interested to see, that was advanced quite independently by the Editor of the *Steam Engineer* in its current number. In the early days of fuel efficiency it was necessary to carry the gospel to every consumer. We measured action in those days by the number of visits paid each month. Now it begins to look as if we shall do better by searching for those consumers who have the greatest potentiality for improvement and the greatest interest in saving fuel, and staying with them until the increase in efficiency is realized.

We have been set some very big targets for saving fuel—and one of the biggest was that set by Sir Ernest. It may not be sound ballistics but I believe it may prove good sense to say that, if we are to knock the targets to pieces, we must give up using shotguns and start using rifles. In other words, it begins to look as if we should no longer assess our engineers' activity by the number of fresh premises they enter every year, but by the number of firms to which they pay regular visits in order to bring their fuel efficiency to the highest possible pitch. Recommendations are no good if they are not translated into action.

Certainly it is most encouraging to N.I.F.E.S. to receive so many requests for regular service throughout the year, and while we must retain a strategic reserve to meet emergency requests for help, we shall naturally plan to give priority to these annual customers.

Now, if I may, I should like to speak for a minute particularly to the large number in the audience who represent local authorities. There are two ways in which we are anxious to establish co-operation in the joint cause—for such it is—of smoke prevention and fuel efficiency. First we are very willing to continue the arrangement that existed with the Ministry of Fuel and Power, by which our engineers will give advice to any industrial firm, whose chimneys are emitting smoke to the concern of the local authority. Indeed this work is already occupying a good part of N.I.F.E.S.' time. Speaking from memory, we are dealing with about 100 such cases every month.

It is therefore open to any local authority which considers that a firm needs help in smoke prevention to advise that firm to call in N.I.F.E.S., and we shall do our best. We naturally do not consider that it is for us to take part in court proceedings, but I know that your objective is to cure smoke emission, not to pile up prosecutions. Indeed, it was evident from yesterday's discussion that this Society recognizes that the real force behind it is the force of public opinion, and I have been greatly struck, in returning to this country after five years' absence, to find how much opinion has moved in industry towards the recognition of the importance of smoke abatement.

Second, I should like to speak to local authorities as very considerable fuel consumers in aggregate, and to assure them that N.I.F.E.S. is very anxious to assist them in this respect as well. With their many buildings scattered through their whole areas, local authorities have a difficult problem to maintain a high standard of fuel efficiency, and as a consequence I notice they are not always guiltless of committing smoke nuisances as well. N.I.F.E.S. is entering into arrangements with local authorities for regular visits to their boiler plants—either by engineers to report on maintenance or by demonstrators to help the boiler operators. We are anxious to extend these arrangements, and I hope that after this meeting many of the local authorities represented here will get in touch with our Area Engineers and see what they can offer to help them.

Finally—and really I should have put this first—we have been spending a good deal of time in discussion with those organizations that are already giving technical advice to industrial fuel consumers. N.I.F.E.S. motto is "To supplement, and not to supplant," and we are anxious to be the backer-up of the consultants and the fuel distributors—to mention only two—who are eager to raise the efficiency of fuel utilization. It is in this spirit that I have said nothing today about efficiency in the utilization of gas and electricity by industry. N.I.F.E.S. is concerned with the use of all fuels and all forms of energy, but I think you will be able to agree when you have heard the papers Mr. Hayman and Mr. Bernard will now be presenting that the gas and electricity industries are far along the road towards providing an effective service in fuel utilization.

G. Nonhebel in opening the discussion complimented Messrs. Hayman and Bernard on their able and

thorough presentation of developments in the industrial uses of gas and electricity. He hoped that members would appreciate the effort involved in the preparation of these papers.

After listening to the opening speech of the afternoon by Dr. Macfarlane on the functions of the National Industrial Fuel Efficiency Service, he thought that a suitable title for the afternoon's session might have been " Service to Industry." They were, however, gathered together to discuss smoke abatement and from the contents of parts of the two papers he had decided that a more appropriate title would be " How to Make Money by Smoke Abatement."

Both papers had given many examples of manufactures which when operated with coal had emitted smoke or dust but which had been brought up-to-date and rendered smokeless by use of either gas or electricity. The new and often expensive equipment described had not been installed merely in the interests of smoke abatement but because it enabled greater productivity to be obtained per man and per unit of capital, gave a better and more competitive product and improved working conditions. The last point was becoming of increasing importance. In these days of full employment it was more and more difficult to obtain men to work in unnecessarily dirty and unpleasant conditions. Moreover, when there was a choice of employment a young man would naturally choose to go to a factory using up-to-date equipment and some of the wonderful instruments described in the papers.

Mr. Bernard gave one example of the return on new capital to be obtained by using modern equipment. If the estimates in Table IV were correct, it was cheaper in both capital and operating costs to use electric furnaces for certain steelmaking processes, and there would be a handsome return even if account was taken of the capital value of old plant displaced by the new equipment. He hoped that Mr. Hayman would give in his written reply an example of the return on capital to be obtained by changing one of the processes he described from coal to gas.

In that connection he wished to draw attention to the Government Loan Scheme for approved fuel saving projects operated by the Ministry of Fuel and Power. Most of those would at the same time reduce smoke emission. The Scheme was particularly designed to help the smaller firms which had more difficulty in obtaining finance for improvements. Briefly no interest was payable for the first two years and thereafter at present at 4 per cent. The capital had only to be repaid over a period of 20 years. He hoped that the Advisory Services of the gas and electricity industries would, where appropriate, assist firms operating smoky processes to obtain these loans.

The Society was always interested in achieved reductions in smoke. Mr. Hayman had shown in paragraph 2.1 that 600,000 tons of coal had been displaced by gas in the Potteries. If the smoke produced was only 1 per cent of the coal fired, and he believed this an under-estimate, the reduction in smoke, assuming the same output, was 6,000 tons per year in that one small area alone.

By making fuel do more work, there would also be a reduction of smoke and dust provided there was the same efficiency of prevention. Thus Mr. Bernard mentioned use of electricity, but he could have added there was less atmospheric pollution when the electricity was generated by H. P. boilers with back-pressure turbines and the exhaust steam from the turbines used for process purposes in other parts of a factory than when the electricity was generated in an ordinary power station and separate low pressure boilers were used to provide steam for the factory.

There were to his knowledge at least three processes where it was claimed that smoky atmospheres were required. These were:

The burning of blue brick.

The low temperature heat treatment (below 800°C.) of steel billets.

The production of wrought iron from pig iron and subsequent working of the iron.

He asked what hopes the gas or electricity industries, either together or in combination, had in solving these problems.

Dr. H. Hollings pointed out that this paper dealt only with the application of town gas and omitted reference to developments in the industrial uses of producer gas. This was a matter of which the Society should not lose sight because developments were in fact taking place and the substitution of producer gas for raw coal in suitable industries could make an immediate and direct contribution to smoke abatement.

Turning to the research of the Flame Radiation Committee he emphasized that this might have application beyond the confines of the steel industry. It might have significance in almost any industrial furnace burning fuel. The work would shortly be extended to include a study of the combustion of producer gas made from coal and of pulverized coal. He supported Mr. Hayman in bringing this work to the notice of the Society because although it might appear somewhat academic at present it could have a definite contribution to make to smoke abatement in the not far distant future.

W. R. T. Skinner (South Eastern Electricity Board) said that although the use of electricity for heating was one way of keeping the production of smoke down to the practicable minimum, it was sometimes argued, on other grounds, that electricity should not be used for heating at all. There could be two schools of thought on that subject and he did not propose to discuss the proposition as a whole. Mr. Bernard had produced illuminating evidence that electric heating in some applications not only was clean, but also saved coal, expense, space and time, so that whatever our general views, our consciences could be quite clear in adopting such applications in the interests of smoke abatement. He particularly wanted to emphasize two of the methods of heating mentioned by Mr. Bernard because both were peculiarly electrical and neither could be matched by other forms of heating. He referred to induction heating of electrically conducting materials and dielectric heating of non-conducting materials, both of which methods were distinguished by the generation of heat exactly where it was wanted with the material itself. These methods were not only quick, but, because the heat had not to be separately generated and then transmitted to the work by radiation, convection or conduction, they were also highly efficient. He suggested that there again, whatever our general views on the propriety or otherwise of electric heating, our consciences could be quite clear in adopting either of these highly efficient methods in the interests of smoke abatement.

C. H. Crawford (Brierley Hill U.D.C.) said that the electricity industry's paper had given illustrations of the way in which small power machines help in cabinet making and similar work. That morning Conference had seen a film showing some of the filth with which railway engine cleaners had to contend. He thought the contrast between the two industries was astounding. Could Mr. Bernard say briefly whether he could clean up the engine cleaner's work and how he would set about it.

Councillor Eric B. Gibbons suggested that future increases of Plant should be designed so that part of the Plant could come into operation at an early date, obviating a very wide gap while the whole Plant was built, and asked whether in some cases the competition between gas and electricity was not too keen resulting in the user on occasions installing the wrong Plant, and waste in running both services on a large scale to the same factory.

One kiln in the Potteries illustrated

in the paper burns about 10,000 cubic feet of gas per hour, necessitating the carbonization of 100 tons of coal per week at the gasworks. To achieve this same output in periodic kilns would have needed 220 tons of coal per week, so that in this one kiln alone there is a saving of 120 tons of coal per week, with nearly 50 tons of coke, plus tar and benzole, thrown in for good measure.

W. P. Warren (South Wales Electricity Board) stated that the Conference, as with its predecessors, had as its ultimate objective the abolition of air pollution, and it must be that all delegates present subscribed to that objective. He indicated that whilst that was unquestionably paramount in the minds of all delegates he had some misgivings whilst listening to some of the contributions to the discussion, particularly on the previous day, that their main objective was somewhat tempered by the desire to publicize a particular form of smokeless fuel.

He said that it would be a great pity if the main impetus of the Society's attack—based on a wholly united and concerted effort—should be somewhat deviated by the individual campaigns of benefiting parties.

He said it must be conceded that each form of smokeless fuel had its uses, though it was perhaps in one way unfortunate that in certain processes, as in industrial and domestic heating, the various smokeless fuels could all perform somewhat similar functions. Though it was true that some allowed (*a*) more accurate control; (*b*) more efficient and economic use and (*c*) a complete absence of fumes, as compared with the other fuels.

In that connection Mr. Warren felt that advocacy of a particular one of those competing fuels should not be the task of the National Smoke Abatement Society. By all means let members be acquainted with the alternative fuels and equipments but also let them stand aside from the normal commercial field of battle, where the competing fuel industries already met in a spirit of friendly rivalry.

He said that they had been confronted that afternoon by two most excellent papers—well prepared and exceptionally well delivered, but in the short space of time available would anyone, other than an engineer from either side the Gas or Electricity Industries, care to comment on the relative merits of a particular process apparently capable of operation by the use of either of these fuels.

Mr. Warren said it was apparent that the ultimate implementation of a " pure air " Policy will rest correctly with the Local Authorities, but not equally apparent was the source of up-to-date technical and commercial advice for the alternative fuels and equipments.

He said that Dr. White had referred to the advice which would be given by his staff on the alternative smoke free methods which would be necessary in implementing the " smoke-free " zone in the City of London. Mr. Warren said he would like very much to hear Dr. White's opinion and the opinion of other Local Government Officials on the desirability of having in each area some form of technical panel comprising representatives of N.I.F.E.S., the gas, solid fuel, oil and electricity industries, to which panel could be referred any consumer requiring information on alternative smoke free processes. The main aim of the Society was the abolition of air pollution—not only of smoke as such —but of all the injurious and obnoxious vapours, particularly of the sulphurous class. If that objective were to be achieved Mr. Warren thought the Society should make impartially available to the consumer the knowledge and resources of the various fuel industries and leave to him the choice of method he is to adopt.

In conclusion Mr. Warren said if in his contribution he had emphasized his normal professional interest, he

claimed the right of precedent, but much more he would have preferred to have conveyed the need for a concerted and unified action irrespective of the side issues and commercial benefits accruing.

Dr. A. Parker (Fuel Research Station) said he had listened with very great interest not only to the papers given by Mr. Hayman and Mr. Bernard, but also to the introductory remarks by the Chairman, who had given quite a useful statement about the activities of N.I.F.E.S.

Here we had two competitive industries, gas and electricity. They were quite friendly, and it was what he would call friendly competition. He thought this was a good thing, for without such competition they would never get the real drive to maximum efficiency—provided of course the competition did not go on the wrong lines. In the paper on gas they had had excellent examples of a number of industries where productivity had been increased and fuel saved and the conditions vastly improved for the working operatives. This was particularly the case in the ceramics and the steel industry and he could assure the meeting that there had been an enormous improvement in the ceramics industry as a result of the rapid introduction of gas fired tunnel kilns. They had had other examples for electricity, for furnaces, and of course a great increase in power is absolutely necessary if productivity per man in this country is to go on increasing. Now why had all these people increased their use of gas and electricity? As Mr. Nonhebel had said, it was a matter of cost, cost of the ultimate service to the consumer measured in amount per unit of production and that was all to the good.

What was the effect on smoke abatement? Let us look at the position immediately before the war, say 1938. The home consumption of coal in this industry in 1938 was roughly 175 million tons a year, it was now 205 million tons. Supposing we had gone on using that coal pretty well in the same proportion and method at the present time as we did before the war—we certainly should have had more smoke, more grit, more pollution. But what did we find? We found that we were now carbonizing more than ten million tons of coal a year more in the gas industry and coke ovens than we were before the war, and were using roughly 20 million more tons a year in producing electricity. In fact the whole of the increase in the use of coal from 1938 to the present time had been taken up by methods which did not produce smoke and if we had not had that then we should have had more smoke now than we had before the war.

With regard to smoke emission from certain types of furnace in the steel industry, by installing mechanical stokers and proper operation, that smoke emission could largely be avoided with no increase in scaling of the metal. It was a question of demonstration and then pressing for the installation of the improved equipment. Furnace owners said it cost money but it was not really expensive and he could not think that people owning some of the smaller furnaces were going to go bankrupt for the sake of spending say £500 on an automatic stoker.

R. McGlashen (South West Scotland Electricity Board) said that he had found both of the Papers most interesting and was sure that if their common message was accepted by industrialists, the interests of the Society would be well served. He noted, however, that nothing had been said on the important subject of space heating (or comfort heating) of industrial and commercial premises.

Dr. White, in his statement the previous day, had stressed the considerable practical difficulties which had to be faced over the introduction of Smokeless Zone Regulations in the densely occupied business community of the City of London, with its thousands of small independent offices formerly heated by domestic type open coal grates.

Mr. McGlashen felt that the Conference might be interested to hear of how owners of similar offices in the business area of Glasgow were turning to a form of smokeless space heating at a rate which had increased rapidly over the past year. He referred to the Electric Thermal Storage Block-Heater comprising a massive block of artificial stone in a case, having the appearance of, and having the dimensions of, a normal electric convector heater. Electricity heated the stone overnight and gave out the stored heat to maintain a comfortable temperature in the premises during the following day when electricity supply to the heater was switched off. That form of heating was in the national interests because it made better use of electricity generating plant and main cables during the night when much of that costly equipment is normally lying idle. For that reason, most Electricity Boards are able to offer a considerably reduced tariff for such loads, sometimes at less than half the normal rates of charge. It was attractive to property owners, not only because of its convenience, automatic control, ease of installation and low running costs, but also because of its low initial cost: the thermal storage heaters may often be connected without any need to strengthen the consumer's service cables, since they were only used when the normal day-time load was switched off, and for that reason the total capital expenditure may not exceed £20 (including heater) in a small office, or an average of £15 per room for a larger group of offices.

He wished to emphasize that the use of that form of space heating was expanding on its merits alone. (There was no smokeless zone legislation in Glasgow), and he thought it would be pleasing to members of the Society to hear of this recent rapid expansion in the use of an old form of electric heating, in view of the contribution it made to the realization of the Society's aims and objects.

Dr. T. P. Colclough (British Iron and Steel Federation) said there were one or two points in the papers on which comment was perhaps desirable. The first was that while they were all absolutely strong in their efforts to replace the use of solid fuel by gas and electricity, and endorsed, in general, the principles outlined by the authors, one would not like it to go out from the Conference that the use of gas in steelmaking would solve the smoke problem. It should be remembered that 90 per cent. of the steel made in this country was made in open hearth furnaces and those were all gas fired and always had been; and one did not known anybody who would claim that they were free from smoke.

The second point was the replacement of open hearth furnaces by electric furnaces for steelmaking. A special part of the paper was devoted to that question, and Mr. Nonhebel had made special reference to it in opening the discussion. In the comparison which had been presented in the paper—and which in fairness was only an extract from another paper, so that Mr. Bernard bore no responsibility for it—there was a prejudiced statement of the position. In the electric furnace installation, it would be necessary to instal some power-generating units. The cost of those units was not given. If they installed the minimum units necessary to supply the power to those furnaces, it could be estimated that the capital expenditure would be increased by £0.75 million, and if they had the usual safety margin which the public authorities must have in order to guarantee supply, that would have to be multiplied by 1½ or 2. The difference, then, in capital expenditure would be nothing like that which was given.

A futher point was that although there were certain safeguards in the text, the figures which were given for the cost of metal bore no relation whatever to the actual facts of today. That being the case, the suggested saving of 50s. per ton, which was quoted in the paper and was quoted by Mr. Nonhebel, and the mythical

saving of 25 per cent. had no real basis.

He had to make those corrections, because he knew how valuable the papers that they got at the Conferences were as material for spreading the gospel, and it was desirable that all such information should be unchallengeable.

W. A. Lloyd Dodd (Northern Gas Board) in a contribution received after the Conference wrote: in speaking of the extension of the use of gas in the Pottery Industry, and the only too obvious effect of the substitution of this fuel for coal upon smoke emission in the Stoke-on-Trent area, Mr. Hayman touched upon a most important point—namely that the gas used in 1952 compared with an estimated figure of 336,000 tons of coal which would have been required for the same production in direct coal fired kilns.

It may be argued that in this case there was also involved a change-over from intermittent to more efficient tunnel kilns and, while this is true, it must be remembered that the above statement of tonnage saved ignores the coke and by-products simultaneously produced.

To make my point that almost every conversion of Industrial heating plant from coal to gas firing means, not only the abatement of atmospheric pollution, but also a national saving in coal, it is perhaps simplest and of most interest to give an actual example for which detailed figures are available.

In 1949 the coal consumption of a frame heating furnace at a North East Shipyard averaged 30 tons per week. On conversion to gas firing the gas consumption averaged 1,818 therms per week which is equivalent to the consumption of only 23 tons of coal per week at the Gas Works. There was thus a National saving of coal of seven tons per week, but in addition there was made available to other consumers some 12 tons of coke, 230 gallons of tar, 58 gallons benzole, together with ammonium sulphate and other by-products.

Pollution of the atmosphere when this furnace was fired by coal will have been something of the order of 17 tons per year smoke, 5 tons per year grit, 53 tons per year sulphur dioxide, these figures being based on the assumption that the furnace was typical of direct coal fired Industrial plant, figures for the pollution from which were given by the Director of Fuel Research in his recent Paper to the British Association at Oxford.

With gas firing the pollution will have been reduced to, even including the products of combustion emitted when coke produced at the same time is burned elsewhere, 19 tons per year of sulphur dioxide with little ash and no smoke.

There is thus in all such cases of the use of gas in Industry in place of coal, not only a marked reduction in atmospheric pollution, but also a considerable National saving in coal, a factor of vital interest at the present time.

Mr. Hayman, in his reply, said that in answer to Mr. Nonhebel it was difficult to quote accurate comparative costs where gas had replaced solid fuel. If the same process was not carried out in the same furnace other features, for instance, a change of operating technique, greater production and quicker heating up, would colour the figures and lead to false conclusions. Further, in several cases where a changeover had been made, other modifications had been carried out at the same time and where the total production had increased some firms were naturally reluctant to disclose the new figures. Collection of such figures was, however, an important exercise for the near future. Regarding the three processes, Mr. Nonhebel mentioned, where it was claimed a smoky atmosphere was required, Mr. Hayman wondered whether it was not a smoky atmosphere so much as a reducing, neutral or, in effect, a controlled atmosphere which was needed.

The manufacture of bricks doubtless could be carried out by gas as the

large numbers of ceramic kilns in the Potteries showed, but the production of ordinary bricks was nearly always carried out in areas remote from large sources of gas, even supposing it was economical to use this fuel.

The heat treatment of steel was being carried out successfully in very many installations under controlled conditions. Concerning the final point, the production of wrought iron was a process in which town gas, or coke oven gas did not figure largely at the moment, for economic reasons and the solution of this problem may lie in the future if it was possible to use gas in large quantities for this process.

Dr. Hollings was quite right in drawing attention to developments in the use of producer gas, but the paper had to be restricted to town gas and similar gases. The author was glad Dr. Hollings stressed the value of the work of the Flame Radiation Research Joint Committee. This work was of vital long term importance to all furnace builders.

"The author thanked Councillor Eric Gibbons for his valuable comparative figures. He agreed with him on the importance of avoiding waste and said that by intelligent handling of situations as they arose it should be possible to use the right fuel in the right place. With that outlook, not necessarily the same as selling gas for all processes, there was still enormous scope."

He was grateful to Dr. Parker for his support of the efforts which both gas and electricity were contributing to Smoke Abatement.

He thanked Mr. Lloyd-Dodd for his written contribution and stressed that the presentation of figures was often difficult, as he said earlier. The example quoted was most valuable and may help to answer Mr. Nonhebel's request for comparative figures.

Mr. Bernard in reply expressed his appreciation of the support Mr. Nonhebel had given to the chief proposition made in his paper, namely, that the increased use of electricity had made an important contribution to smoke abatement; although, as he said, the motive had usually been greater productivity rather than smoke abatement as an end in itself. Dr. Parker had put the matter in a nutshell by pointing out that the whole of the increased industrial use of coal from 1938 to the present time had been taken up by methods which did not produce smoke; were it not so we should now have much more smoke than we had before the war.

He was obliged to Mr. Skinner for drawing attention to the fact that high efficiency was inherent in electric induction and dielectric heating because all the heat is developed in the material being treated and heat losses are reduced to very small proportions.

In reply to Mr. Crawford's question he was sure that electricity could help to clean up engine cleaners' work by the greater use of portable electric tools and lamps.

In regard to Councillor Gibbons' question whether competition between gas and electricity was not too keen, Mr. Bernard was strongly of the opinion that competition was very much in the interest of the consumer and the cost of any duplication of services was negligible in comparison with the value of the output of the industries served by electricity and gas.

The use of electric thermal storage space heaters mentioned by Mr. McGlashen was an important additional means of smoke abatement, especially, as he said, in offices and warehouses in business areas which might become smokeless zones. The convenience and economy of this type of electric heating was becoming more widely recognized both in the form of storage block heaters and also by means of heating cables installed in the floors of new buildings.

In reply to Dr. Colclough's comments Mr. Bernard wished to make it clear that the comparison he had quoted for steel making in open-hearth and electric furnaces was quite complete in itself, and so there was no

need to consider the provision of private generating plant because the electricity costs included purchase of current from the public supply, which was undoubtedly the best policy in the case of a fluctuating load like an arc furnace.

The estimated saving by the use of an electric furnace of £2 10s. 0d. per ton related to the American comparison and might perhaps have been more appropriately expressed as 7 dollars. As regards the British comparison which showed a saving of £1 10s. 0d. a ton, the cost of metal was taken at £6 6s. 0d. per ton for steel scrap and £14 6s. 6d. per ton for pig iron, which were the ruling prices as quoted in the techical press in June, 1954.

As mentioned in the paper the system of levies in force in this country to encourage the use of pig iron rather than scrap complicate any calculation and if all the scrap used were to be bought in, the margin in favour of the arc furnace would be considerably reduced, but if on the other hand all the scrap were home produced, i.e., in the same or associated works as that in which the arc furnace is operated, the price would be considerably less than £6 6s. 0d. a ton. It can be agreed that cost figures must be worked out for each individual case and that these will vary from works to works but that did not justify the comment that the figures quoted "bore no relation whatever to the actual facts of today." Mr. J. C. Howard, whose figures had been quoted, emphasized that the present system of levies does in fact mean that a user of an electric arc furnace for plain carbon steel production, is in fact subsidizing the steel maker who uses pig iron in the open-hearth furnace.

The Fifth Des Vœux Memorial Lecture

AIR POLLUTION AND PLANT LIFE

by

Sir Edward J. Salisbury, C.B.E., D.Sc., LL.D., Sec.R.S.

Director, Royal Botanic Gardens, Kew.

THE subject of my lecture to-day is the deleterious effects of atmospheric pollution upon living plants. Hence it is somewhat ironical that the wanton squandering of the capital stores of energy in the form of coal, amassed by the palaeozoic forests of many millions of years ago, should be the cause of depressing our living vegetation of to-day. In the phraseology of Shelley, " smoke is like a desolating pestilence that pollutes whate'er it touches," and it adds nothing to our tolerance that the besmirching of the countryside which followed in train of the industrial revolution has been due in no small degree to wasteful exploitation of our natural resources.

The impurities in the atmosphere that arise from the burning of coal affect plant life in a variety of ways. Some of which—soot and dust are examples—may be mainly or exclusively physical in their primary action producing physiological effects as a secondary consequence. Such impurities become significant only when present in appreciable amounts. In a *second* category are such gaseous impurities as ethylene, actylene and carbon monoxide, which though usually present in very great dilution and, in low concentrations, at least, not markedly lethal, are nevertheless capable of inducing appreciable adverse effects on plant growth, even when present in amounts measured in parts per million. *Thirdly*, there are gaseous impurities, such as Sulphur Dioxide, Ammonia, Chlorine and Hydrogen Sulphide, which are highly lethal to plant life, and in small quantities can bring vital activities to an end, although in sublethal doses they appear to have little, if any, influence on the manner of growth. *Fourthly*, there are impurities which manifest their deleterious effects not directly on plant life, so much as on the animals that feed upon them. The deleterious influence of atmospheric pollution on plant life has naturally been a phenomenon that has forced itself upon the notice of cultivators of plants ever since the industrial revolution inaugurated the greatly accelerated production of smoke. In a recent lecture in this series, attention was called to pollution as the cause of Curtis moving his garden from Waterloo to Brompton, nearly two-hundred years ago ; and the sad decline in London's gardens since the time when the Bishops of Ely cultivated their grapes at Vine Street in the XIVth Century, and the Archbishops grew pears at Lambeth, is one which continued unchecked until recent years.

The physical effects of the particulate impurities in the atmosphere are emphasized by the benefits that can accrue from washing the foliage of such evergreens as Laurels, Camellias, Rhododendrons and Aucubas growing in London gardens. Again, attention was called many years ago to the fact that lichens on the trunks of trees in Epping forest flourished only on the side remote from London. On the other side, the prevailing S.W. winds brought and deposited soot and dust. Since it may be assumed that any de-

leterious gases would reach the eastern side of the trunk almost as readily as the western, one may infer that here we have a demonstration of the efficacy of a smoke shadow.

Little is known concerning possible benefits to plant life from atmospheric pollution although it would appear that any such are far outweighed by the deleterious effects. In this connection we must, however, note that Mr. Patterson found that on a leaf from the Bristol area, on which there was 1/20 oz. of deposit, this contained copper, aluminium, lead and zinc. It would seem probable, therefore, that atmospheric pollution may be a means of supply of essential trace element deficiencies.

It has indeed been found, for example, that very small dosages of sulphur dioxide, (e.g., 0.2 p.p.m.), may be slightly stimulating to plants growing on soils deficient in sulphur.

It was in 1890 that the Royal Horticultural Society invited the late Professor F. W. Oliver to investigate the effect of urban fogs on plant life, and his results constitute the foundation of our scientific knowledge of the subject (*Jour. R.H.S.* 1891, 13, p.139). Oliver was the first to provide quantitative data as to the magnitude of the deposit which the fogs of those days could leave. I, myself, and others in this audience, are probably old enough to recall the notorious " London Particulars " of the later years of the 19th Century when almost without warning, a complete pall of blackness would descend upon the City even in broad daylight, and one's handkerchief soon looked as if it had been used to sweep a chimney. It is in no small degree a tribute to the efforts of the Smoke Abatement Society that the worst horrors of such days no longer descend upon us, although much improvement remains to be achieved.

We can conveniently consider the subject matter of this address under three headings, namely, (1) The physical action of pollution on plant life, (2) The physiological effects of particular impurities, (3) The indirect action of pollution.

Amongst the most important of the purely physical effects is the obvious one of the deposition of grime upon the surface of the foliage and upon the glass of our greenhouses. Sixty years ago Oliver found that within three weeks the glass at Kew could accrete two grams of grime on every square yard, and the labour involved to-day in keeping the glasshouses clean bears witness to the fact that conditions, though improved, are far from satisfactory. Indeed, the loss of light to the plants consequent upon this darkening of the surface is a serious handicap to the glasshouse industry and is mainly responsible for the transfer of the Glasshouse Research Station from Cheshunt to Sussex.

The physical effect upon the light received by the leaf and upon which its efficiency as a food factory depends, is in fact twofold : there is the screen interposed by the deposit upon the leaf itself, and if the plant be grown in a greenhouse there is also the screen provided by the dirty glass. Recent determinations at Kew indicate that this last may cause a diminution of 40 per cent. Further, there is the loss of transparency of the atmosphere itself. All these diminuting influences are more important in the period of the year when the sun is at a low angle, and the insolation, even in areas more or less free from pollution, is naturally low. Such diminution may not play a very significant part in affecting the growth of those plants whose main activity is in the summer months when pollution is minimal, but it is a very significant factor in species with a brief foliar cycle such as some of the spring flowers, which perhaps explains the intolerance for pollution of Winter Aconites and Snowdrops. It is true we see these in city parks, but their corms and bulbs call for constant renewal. I recall some cultures of the Wild Hyacinth in the London atmosphere which I carried on for several years. These plants ceased flowering in the second year, and in the following seasons exhibited a steadily diminishing weight of bulb and succumbed in the fifth year, more, I think, from lack

of light than from the toxic effects of pollution, to be considered later. During winter the diminution of atmospheric transparency may attain to 80 per cent whilst in summer it is of the order of 5-15 per cent which, added to the grime screen on the leaf itself, is not unimportant.

The data furnished by Napier Shaw and Owens indicate a range during fogs of from 20,000 to 50,000 particles per cubic centimetre, compared with 15 in the Bay of Biscay, but the real question is what proportion of this actually comes to rest on the leaf surface. On the basis of average measurements we can calculate that over 100,000 smoke particles would be required to cover a square inch of leaf surface which is only the particle content of about one-third of a cubic inch of air in a moderate fog.

Most of the particles present in the polluted atmosphere are of so small a size that if gravity were solely responsible, in still air, they would require a period of nearly half-an-hour to sink downwards one inch. The chance of absolute calm for such a period in our climate is remote. Hence it is obvious that the probability of the finer particles settling on to foliage, through gravity alone, is unlikely, though this becomes less so the larger the particles involved, the rate and settling varying directly as the square of the particle radius.

How then does the grime get on to the leaves ? Probably the main factor is the turbulence that carries the particles on to the leaf surfaces. If turbulence were chiefly involved, we might expect approximately equal amounts of grime to reach both lower and upper surfaces, and in fact I have found Holm Oak leaves at Kew on the lower twigs, beneath the umbrella of the main foliar canopy, in which the grime of the lower surface was actually slightly in excess of that on the upper. Examination of a number of leaves in which the weight of grime was determined separately for the two surfaces, showed a remarkable uniformity in deposit per unit area for a variety of leaf sizes and a diversity of species. On most of the leaves examined the grime on the upper surface was about 1.1 mg./sq. in., and on the lower approximately two-thirds to a half of that figure.

DEPOSIT ON LEAVES AT KEW

	Range of leaf area in sq. ins.	Deposit /sq. in. Upper surface mgs.	Deposit /sq. in. Lower surface mgs.
Camellia	2.3–8.27	0.7 –1.75	0.4 –0.6
Holly	2.1–7.3	0.96–1.40	0.41–0.47
Rhododendron	1.7–3.1	1.01–1.16	0.59–0.61
Ivy	5.8–8.1	1.2 –1.3	0.30–0.69
Q. Ilex	2.7–4.2	1.08–1.60	1.8 –1.9

Ruston in the Leeds area obtained data that showed a deposit of from 0.0131 to 0.0833 milligrams per sq. centimetre, the average for the suburban region being .0313. Much higher deposits were found by me on old Camellia leaves at Kew, on which the total deposit on both surfaces was 0.337 milligrams per sq. centimetre. J. H. Cost, who examined the deposit on Aucuba leaves in different areas in Hyde Park, found the amount to be ten times greater on the leaves from

one bush than from those of another only about 1 mile away.

The amount of grime does not appear to vary very markedly from species to species, and not as much as the difference just cited amongst those with similar foliage but differing susceptibility so that this aspect would not seem likely to be an important factor in determining tolerance.

Evergreens not unnaturally are especially susceptible to damage since their leaves may not only function for more than a single season, but are present during the winter months when pollution of the atmosphere is maximal. Conversely, the deciduous species may be said to evade in large measure the effects of pollution, since the new foliage is not produced until the worst period of smoke production is past, and the leaves are shed about the time of the year when domestic fires become a daily feature. The leaves of the Douglas Fir may remain on the tree for over six years, so not only is the leaf surface not annually renewed, but it continues throughout several years to accumulate more and more grime, whereas the deciduous tree starts each season with a relatively clean leaf surface. The leaves of the Holly and the Ivy are retained for over two years before being shed, but the needles of many Pines may function for three or four years, hence, perhaps, their marked susceptibility to pollution. Even though the evergreen can manufacture some food during the period when the deciduous tree is bare of foliage or in process of developing its leaves, the light intensity during the winter season is too low to penetrate the film of grime to an extent that is any appreciable compensation in effective food manufacture. Moreover, A. G. Ruston called attention to the fact that in conditions of severe pollution the evergreen may in fact become deciduous, but the period of leaflessness is more prolonged the greater the atmospheric pollution, and this is true of the deciduous tree also, which may lose its leaves six to eight weeks earlier than normal. One can, therefore, summarize this aspect by saying that one effect of pollution is to curtail the length of the plant's working year and to reduce its efficiency during this abbreviated period by interposing a screen of grime between the sunlight and the chloroplasts so that the supply of radiant energy that supplies the power for the plant's factory is diminished.

But the production of sugars by the green leaf is dependent not only on the supply of energy from the sun, but also on certain raw materials of which carbon dioxide is one. The polluted atmosphere in and around cities may contain a very slightly higher proportion of this gas than is present in the cleaner atmosphere of the country, but despite this, the blocking of the pores in the skin of the leaf by tarry substances may check diffusion to an extent that retards gaseous diffusion and thus further materially limits the rate of food manufacture in the foliage. This blocking of the stomata may be more significant than some have supposed. The average size of smoke particles is, according to Napier, Shaw & Owens, of the order of 0.78μ which is appreciably less than the 3 to 4μ that is the average width of an open stoma. Moreover, the frequent absence of obvious grime on the lower surface but its manifest presence when such a surface is wiped with cotton-wool, does suggest that stomatal occlusion may well be brought about by an oily film which is not visible as an opaque deposit ; be this as it may, tests with a porometer suggest that the stoppage is not inappreciable. It is probable, too, that the rate of respiration of plants in a polluted atmosphere is significantly higher than in clean air, so that the compensation point, at which the rate of food production only just balances the rate of consumption by respiration, is more often approached or even attained than under favourable environmental conditions. Hence the balance available for growth is often small, still less is there a margin sufficient for reproduction, so that flowering may be

greatly reduced, and fruiting negligible or absent.

The differences in susceptibility of different species can be in part related to the duration of their foliage, whilst the surface may or may not facilitate the accumulation of grime ; though this factor is, perhaps, mostly insignificant. Physiological differences, in sensitiveness to the lethal gases and to the effects of pollution on the soil, are also involved.

The tolerance of different species to atmospheric pollution is remarkably varied. One of those which survives better than most is the Common Elder (*Sambucus nigra*). The late Dean of Windsor, in his autobiography recalling his Tyneside experiences, wrote, "A nearby chemical works created a pall of smoke that overhung the whole district and killed all vegetation except a few anaemic Elder bushes ". Other markedly tolerant species are the Sycamore, the common *Iris germanica*, the London Pride (*Saxifraga geum*), Soldier's Pride (*Centranthus*), and some kinds of Pinks. Amongst the very sensitive garden plants are the Primrose, the Hollyhock and the Calceolaria. Most of the more tolerant species have smooth leaves, whilst the sensitive ones mentioned have hairy foliage, and no doubt the presence of hairs facilitates the accumulation of grime and thus leads to more rapid diminution of the photosynthetic efficiency. But there are several striking exceptions to this generalization respecting the character of the leaf surface, for the Common Hawthorn, which has smooth leaves, is one of the more sensitive species, whilst some varieties of Pelargonium with very hairy leaves are remarkably tolerant.

The extreme tolerance of the Elder may well be due in part to the rapidity of its growth, especially of the cork in the lenticular areas. In this connection it is important to remember that the deciduous tree, when it has shed its leaves, is clothed in a protective and relatively impermeable covering of cork, but carries on its respiratory exchange through the lenticels where the cork cells are not closely packed but interspersed with narrow intercellular spaces. These, too, may become clogged with tarry grime, and the tolerance of the Plane Tree to smoke pollution has been attributed to its capacity for shedding the outer layers of bark and thereby rendering the passages for gaseous exchange again operative.

The indirect influence of pollution on plant life by the effect on soil reaction is clearly shown by the data furnished by Trefor Jones respecting the decreasing sulphate content of the soil of grasslands with increasing distance in the direction of the prevailing winds N.E. from Leeds. At nineteen miles the sulphate content was nearly normal but rose to approximately double at a distance of four miles, and was ten times the normal in the City itself. The high acidity, which may be pH.4 or less, is not only deleterious to plant growth in itself, but in soils rich in iron salts renders these too readily available so that iron toxicity symptoms can develop. Furthermore, the bases are washed out of the soil by the acidified rainwater and rapidly lost in drainage. Radishes, Lettuces and Cabbages were grown in areas in and near Leeds, characterized by different annual amounts of pollution. Initially the soil was the same, but at the end of the experiment the content of calcium carbonate in the soil had diminished more or less proportionately to the amount of SO_3 in the soot.

The high acidity and tarry substances have, moreover, the effect of changing the soil population and in particular the nitrogen fixing bacteria tend to be eliminated and not infrequently there is marked delay in the break down of organic material, so that the cycle of renewal is impaired.

It must not be forgotten, however, that types of pollution, other than that of smoke, may produce the opposite effect on soil reaction. F. J. Sievers has described how in the United States magnesium oxide dust caused severe damage to cereal crops at a

distance of several miles from a factory where magnesium ores were heated. The damage was attributed to the indirect effect of the magnesium oxide which by increasing the alkalinity of the soil rendered certain essential nutrients unavailable. Some British factories are also stated to produce smoke with a high content of magnesium oxide, which dissolved by the rain produces a highly alkaline solution of the order of pH.11 which would be expected to render non-available such ions as manganese, boron, iron, copper and zinc.

In this connection we may recall the calcium dust from the cement kilns of the Dartford area, to which Mr. Regan referred in his Chadwick Lecture.

Stone crushing factories produce dust that may be deleterious solely as a consequence of the fine powder that adheres to foliage and reduces the light that reaches the chloroplasts, the effects being entirely comparable to those exhibited by fields near main roads, about which farmers so bitterly complained in the days when motorists had to wear goggles and women swathed their heads in veils. Here, too, it should be noted that clogging of the stomata by the finest particles accentuates the reduced efficiency of the chloroplasts consequent upon the low intensity of light that reaches them.

But important as are the physical effects that we have considered and the indirect influence of pollution on soil deterioration, it is the direct physiological effects of the toxic gases that constitute the most serious aspect of smoke pollution.

The toxic gases that are present in the polluted atmosphere are of varying importance, both by reason of their differing average concentrations, and their markedly different deleterious effects. Amongst these gases may be mentioned acetylene ($CH{=}CH$), ammonia (NH_3), carbon dioxide (CO_2), carbon monoxide (CO), chlorine (Cl_2), ethylene ($CH_2{=}CH_2$), sulphur dioxide (SO_2) and sulphuretted hydrogen (H_2S).

It has been stated that in Los Angeles the damage to vegetation is mainly the outcome of reaction products of unsaturated hydrocarbons and ozone.

I suppose one of the commonest types of atmospheric pollution is that due to the escape of illuminating gas.

However careful we may be, if we have gas fires, gas cookers, or if gas taps are present for any other reason, some small amount of gas escape is well nigh inevitable, and it is often due to this fact that pot plants or even cut flowers so often last but a short time, and the nurseryman or florist is blamed instead of the atmosphere. That we may not be able to smell any gas escape is no criterion that minute quantities are not present in amounts sufficient to affect vegetation. It is now over half a century since Neljubow showed that as small a quantity as 1 part per million of ethylene could cause distortion in the growth of a Pea seedling, and that this was the prime cause of the effect upon plants of illuminating gas, which often contains about 4 per cent of ethylene. More recent experiments have shown that particularly sensitive species are adversely influenced by one part in ten million, which means that the effect of only one part of illuminating gas in 400,000 parts of air can be manifest. Of all the plants investigated that are specially sensitive to ethylene, the African Marigold was found by Crocker & Zimmerman to be outstanding, since the growth of the leaves of this species was found to respond, by a downward curvature, even when ethylene was present in as low a dilution as one part in a billion, whilst the Potato responded to one part in 300 million. Ethylene is not only present in illuminating gas, but also in the exhaust fumes of motor cars, and even tobacco smoke, so that if you habitually smoke a cigar after dinner the health of the floral decorations may suffer. This gas is also given off in small amounts by ripening apples and other fruits. Since some of the symptoms of ripening are induced or accelerated by ethylene, the

presence of ripe fruit amongst unripe fruit will, unless the ventilation be good, accelerate the process.

Ethylene injury to roots is sometimes manifested by a proliferation of the outer tissues.

Acetylene and carbon monoxide have similar effects to Ethylene but at higher concentration. For acetylene, about 50 parts per million is requisite to produce any marked influence on growth, whilst about ten times that concentration of carbon monoxide is needed to effect similar results. As neither of these gases is usually present in any appreciable amount in polluted air, they are normally unimportant. All three, at the requisite concentrations, produce similar visual symptoms, namely a downward curvature of the leaves, coloration of fruits and, in greater concentrations, leaves, flower-buds, flowers and fruits are liable to be shed.

Computations made by E. Gold (Q.J. Met. Soc. 1954) show that, when traffic is congested, the carbon monoxide content of the air could readily be locally raised to as much as 1 part in 5,000*, and though the warmth of the exhaust gases is conducive to their rapid dispersion when they emerge, it is nevertheless obvious that this source of pollution by a heavy gas such as carbon monoxide might well be a significant factor for plant growth, where conditions are unfavourable for air drainage.

Chlorine as a gas is highly toxic to plants, even 1 part per million being capable of causing severe injury, though fortunately it only constitutes a small fraction of smoke pollution, and chlorine in solution requires 200 to 300 p.p.m. to cause injury.

You may recall the story of the early days of motoring, when the proud possessor of a new motor car was much gratified by the yokel's exclamation, " That be a powerful car, that be, zur,", only to be dashed by the countryman's explanation that he judged the horse-power by the smell. The same psychological reaction is manifest in respect to pollution, since because carbon monoxide is odourless we are apt to deem it harmless, whilst the powerful smell of rotten eggs produced by sulphuretted hydrogen has led to the belief that this is highly toxic. Actually, at equivalent concentrations, the toxicity of H_2S for plants is not high—40 parts per million can effect injury, but about ten times that concentration is requisite to be lethal. The injuries are very similar to those produced by lime-sulphur sprays, and as with the latter there are probably marked differences in sensitivity not only in species but varieties. Carbon monoxide is tolerated by plants in appreciably higher amounts than are present in unpolluted air, and indeed in bright sunshine an increase in the concentrations of this gas increased for many plants the rate of photosynthesis, but the low light intensity that frequently accompanies pollution, often renders this factor the limiting one for the plant's activity, so that no beneficial result accrues from the increased supply of CO_2.

By far the most important of the lethal gases, both by reason of its high toxicity and its concentration in a smoky atmosphere, is sulphur dioxide. Celia Fiennes in the reign of Queen Anne writing of Newcastle stated ' that this country all about is full of this Coale, ye sulphur of it taints ye aire and it smells strongly to strangers '. The average amount of sulphur in coal is about 1.5 per cent, so that every ton of coal burnt provides about 67 lbs. of SO_2, or the equivalent of approximately 100 lbs. of sulphuric acid. In, or near, cities, 0.2 p.p.m. of SO_2 in the air is not infrequent. At the time of the marked temperature inversion with which the disastrous Smog of December, 1952 was associated, the concentration of SO_2 in

*In New York the content of Carbon monoxide is stated to range from 0.04 to 0.2 p.p.m. (Chemical & Engineering News p.1109, 1954). But these figures which are presumably averages, are probably much exceeded locally.

some areas attained to twelve times its normal winter value. At Kew plants of Coleus were blackened and killed as if actually sprayed with sulphuric acid. The winter concentration is usually about twice that in the summer, so that the effect on deciduous and herbaceous species is much reduced. In new York up to 0.86 p.p.m. of SO_2 has been recorded.

Sensitivity to this gas, as with others, varies with the species. At the Boyce-Thompson Institute, where the subject was extensively studied, the Buckwheat was found to be very sensitive, the leaf tissues being killed when less than 0.5 p.p.m. was present in the air, whereas some orchids can withstand 60 p.p.m. Length of exposure is also important because with the lapse of time the SO_2 becomes oxidized to the relatively innocuous sulphate. Resistance is less in shade than in bright light, perhaps partly because moist conditions accentuate injury, and dry conditions reduce it.

The effects of high dilutions of ethylene and sulphur dioxide was investigated by G. S. Varma at Lucknow, who, employing Mangoes as the experimental subject, obtained evidence of marked varietal differences in susceptibility, the lethal dose being almost twice as great with some varieties as with others. Administered separately, these gases produced effects such as lesions, when present in concentrations of approximately three parts per thousand of air, whereas in mixtures of the two gases in equal proportions, small lesions were exhibited at concentrations of only two parts per thousand.

The effect of sulphur dioxide upon foliage was described as far back as 1883 by Schroeder & Renn who found that the tips of the needles of coniferous trees showed characteristic damage, and the leaves of cereals showed similar symptoms, the tips becoming reddened and subsequently bleached. Of the common fruit trees, they found that Cherries are some of the least susceptible to SO_2, whilst Plums are very sensitive. The young leaves are most resistant and the middle-aged leaves most sensitive. Thus we can conclude that the amount of damage caused by these lethal gases is determined by both specific and subspecific differences as well as by the stage of development.

We are all familiar with the fact that organisms generally, in common with ourselves, can endure adverse conditions when in robust health which become increasingly deleterious as the general vigour declines. The same is true of the effects of pollution. Thus in respect of the amount of sulphur dioxide in the atmosphere, it was found by Dr. Metcalfe that a concentration of 1.1 parts per million maintained for a duration of six hours when the air was damp, caused complete defoliation of Begonias. When the air was dry, the damage was reduced. Quite recently, Dr. Bleasdale carried out experiments with Rye Grass which demonstrated that with concentrations as low as 0.01 to 0.06 parts per million, there was a reduction in dry weight yield amounting to 45 per cent less than plants grown in otherwise similar conditions, except that the surrounding air was purified. Moreover, he found that the effects of pollution were ameliorated when the fertility of the soil was augmented. The high acidity which the soil attains, and the degree of leaching to which it is subjected under atmospheric pollution create just those conditions of diminished vigour that accentuate the direct effects of toxic gases and diminished illumination—but perhaps even more important, because more insidious, is that the complex of factors engendered by pollution can appreciably diminish plant growth even when no obvious signs of ill-health are manifest, so that the penumbra of injury to agricultural crops may extend far beyond the zone where smokiness or visible impurity is manifest. In this connection we may note that evidence of pollution has been obtained from 40 to 90 miles from its source.

Spraying plants with dithiocarbamates is alleged to provide some measure of protection against ' smog '.

But how this is effected is not yet known.

Our review has shown that the effects of pollution upon vegetation are both direct and indirect, in part physical and in part chemical, but alike, lowering the efficiency of the activity of plants so that their productivity is diminished.

It is obvious from what I have said that the aims of this Society are calculated to augment materially the vigour of plant life with benefits alike to Agriculture, Forestry and Horticulture and to enhance appreciably the amenities of our environment.

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This is one of the many publications of the National Smoke Abatement Society. For a complete list write to the Society for its current Year Book. This contains a Guide to Publications on Smoke Prevention and Allied Subjects, which lists, in addition to the Society's own titles, particulars of other books, reports and papers, including Government reports, any of which may be purchased from the Society. The list is classified according to subject—the Law, Conference Proceedings, General, Historical, Smoke Prevention Administration, Industrial Smoke, Domestic Heating, Technical and Scientific, and Industrial Pollution.

NATIONAL SMOKE ABATEMENT SOCIETY

Proceedings of the 22nd Annual Conference Bournemouth

September, 1955

Palace Chambers, Bridge Street, London, S.W.1.

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SUMMARY OF EVENTS

The Conference, which was attended by a record number of 578 members and delegates, was opened with an address of welcome by the Worshipful the Mayor of Bournemouth, Councillor D. N. Willoughby, J.P., in the Grand Hall of the Town Hall at 10 o'clock on the morning of Wednesday, 28th September. Sir Ernest Smith, C.B.E., the President, was in the Chair, and after thanking the Mayor for his presence and words, the Presidential Address was read. This was followed by a session on " Any Questions on the Clean Air Bill," with the

Rt. Hon. Alfred Robens, M.P., and Mr. Gerald Nabarro, M.P., answering the many questions that had either been previously put down in writing or were asked from the floor.

In the afternoon of the same day, with Dame Vera Laughton Mathews, D.B.E., Past-President, in the Chair, the Conference heard and discussed a series of five papers on " Recent Progress in Domestic Heating by Centralized Methods." The authors were: Alderman C. P. Russell, M.V.O., and Mr. Bryan Donkin on " The Westminster District Heating Scheme "; Mr. J. W. Moule on " Electrical Floor Warming "; Dr. S. A. Burke on " Small Pipe Central Heating," and Dr. W. Davidson on " Whole House Warming."

In the evening members and delegates attended, by kind invitation of the Mayor and Mayoress of Bournemouth, a reception held on behalf of the Society in the Pavilion.

The Thursday, 29th September, sessions were devoted to consideration of the Beaver Report and the Clean Air Bill. In the morning, with Mr. F. J. Redstone in the Chair, papers were presented by local authority representatives: Alderman C. H. Smith, O.B.E., Councillor Eric Gibbons, Mr. J. Graham and Dr. John Douglas. For the afternoon sessions the papers were by five members of the Beaver Committee: Miss A. D. Boyd, Dr. J. L. Burn, Dr. G. E. Foxwell, C.B.E., Mr. Gordon Nonhebel and Mr. C. J. Regan. The Chairman was Dr. R. Lessing, Vice-President and also a member of the Beaver Committee.

On the Friday morning, 30th September, with the retiring Chairman of the Executive Council, Dr. W. R. Martine, in the Chair, the Sixth Des Voeux Memorial Lecture was read by Dr. A. Parker, C.B.E., Director of the Fuel Research Station, on " The Destructive Effects of Air Pollution on Materials." Before this, the Conference was pleased to hear a few words from Mrs. Des Voeux, widow of the Founder President, who was attending as a delegate of her local authority.

Following the Lecture, the proceedings were concluded with the Annual General Meeting of the Society. A resolution, as follows, was adopted without dissent:

> " This 22nd Annual Conference of the National Smoke Abatement Society welcomes the Government's Clean Air Bill, now before Parliament, as embodying in the broad scope of its proposals the principles for which the Society has always striven. The Society congratulates the Minister of Housing and Local Government upon his speed in implementing the proposals of the Committee on Air Pollution and instructs the Executive Council to continue to afford to the Minister all possible assistance in strengthening the provisions of the Bill."

A further resolution, requesting the Executive Council to prepare a resolution for the 1956 Annual General Meeting, proposing a more appropriate name for the Society, was considered. It was stated that the Council were engaged on reviewing the Constitution generally, and it was agreed therefore that this resolution should be included in the Council's considerations.

Mr. J. J. Matthews, Chairman of the Conference Committee, announced that an invitation had been received and accepted that the next Conference be held in Southport on 3rd-5th October, 1956. The meeting was ended with a general vote of thanks, moved by Dr. J. S. G. Burnett and seconded by Mr. J. Innes, to the authors of papers and sessional Chairmen, to the Mayor and Mayoress of Bournemouth and the Officers of the Corporation, who had co-operated most helpfully in making the arrangements, and to the Conference Committee and Staff of the Society. The motion was carried with acclamation.

Presidential Address

by

Sir Ernest Smith, C.B.E., D.Sc., F.R.I.C., M.I.Gas E., F.Inst.F.

To begin with, I cannot open this address without reference to the loss the Society has sustained in the recent sudden death of Lord Horder, who was to have been my successor as President, and who had been looking forward to being with us today. I need not enlarge on the qualities that made Lord Horder so famous a man, nor on his many achievements, but among them was his keenness—and a very active keenness—for things that promote social well-being, health, and the amenities of life. Among these was smoke abatement. He had been a Vice-President for many years, and he was obviously very pleased when we asked him to accept nomination as President. He was eager to do all he could for the Society. He would have been a tremendous asset to the Society at this important phase of its existence, and I am glad to have this opportunity and privilege of paying him tribute.

This is the 22nd annual conference of the Society, and it creates once again a new record for attendance. We have only to look at the photograph of the inaugural conference in 1929 at Buxton, where the entire meeting was less than the size of our present Executive Council, to see how remarkably the Society has grown.

That small, intimate gathering at Buxton came at the end of a decade of great activity on behalf of cleaner air. There had been the Newton Committee on the Abatement of Smoke and Noxious Vapours—the Beaver Committee was blessed with a shorter title —its prompt and excellent reports, and finally the passing of the new legislation that had been pressed for by our parent associations—the Public Health (Smoke Abatement) Act, 1926.

Yet three years after the passing of the Act the voluntary smoke abatement movement had to be revitalized and a new campaign for clean air had to be begun.

I mention this, not because of forebodings that history is going to repeat itself, but rather as a reminder to a few people—a very few, I think— who suggest that now that the central Government has taken a hand in the campaign, there will be no further need for this Society. I believe that everyone here will agree that the new situation presents the Society with its greatest responsibilities and opportunities so far, just as it gives it cause for satisfaction for the part it has played in creating it.

It is not easy to estimate how much the Society has influenced the shape of things as we see them today, but it is only right to point out that when the Beaver Committee set to work it found, throughout the country, a considerable body of informed opinion, and a broad unanimity of practical views, that had been developed largely through the meetings, discussions and publications of the Society. Not only had the Society brought together all who were concerned about air pollution, but it had filtered and distilled a large variety of ideas into a clear, practical understanding of what the problem was, how it had to be approached, and the lines along which the solutions lay. The Beaver Report is, in effect, very largely an extension and elaboration, in an official framework, of this informed body of opinion.

After these words had been written it was pleasing to find them confirmed by a leader-writer in one of the technical journals. Discussing the Bill and the Society, and kindly concluding

that we were not yet due to fly to that Valhalla in which outworn bodies rest, he went on to say that the Society now had a specialized part to play, mainly among Local Authorities, and that:

> "It has done sterling work throughout its life, and this Bill, even though the offspring of an independent Committee unconnected with the Society, is in fact the culmination of those years of work."

Moreover, the public anxiety about air pollution that followed the shock of the London smog of 1952 could very easily have resulted in all kinds of well-meaning but irresponsible and impractical proposals and demands, had it not been for the core of well-informed understanding that existed throughout the country, again very largely as a result of the years of patient labour by the Society and its members.

We have therefore every reason for looking back with some satisfaction, and even pride, at the achievements of the Society so far—achievements that nevertheless might have been far greater if we had had resources commensurate with the task.

But what of the future? Let us briefly examine the present situation. We are to have a new Act of Parliament, based on the Beaver recommendations, which will have to be administered largely by the Local Authorities, though to some extent by the central Government. For the new Act to succeed it must be used with intelligent earnestness and perseverance throughout the whole country, and it must also be accepted and supported by public opinion. To make it succeed needs therefore the active and continued interest of the Government, the Local Authorities and the public—including, of course, industry. From the very nature of things the Act is unlikely to please everyone, and it may be that some of its provisions will turn out to be less effective in practice than they should be—although it is not likely to fare as badly as did the 1926 Act. In any case, it will be necessary for someone, preferably some critical independent body, to watch carefully the working of the Act and to be ready to say what it thinks.

Further, as the Beaver Committee so well pointed out, there is still a great deal of research and development work to be done, especially on the elimination of fumes and gases, and this too must be encouraged and supported, and the prompt application of its results must be pressed for.

From this very quick and incomplete glance at the near future we can see many important tasks for the Society; tasks which can often be undertaken only by the Society because of its independence, experience and repute. I suggest that they may be listed like this:

(1) To observe, discuss and where necessary make representations about the working of the new Act.

(2) To assist, especially in publicity and education, the more active Local Authorities.

(3) To continue to educate and ginger-up the inactive Local Authorities.

(4) To note and, if necessary, criticize the way the Government departments are doing their part, and to assist them in any way.

(5) To continue to publicize the problem and to educate—and be of service to—the public and industry generally.

(6) To encourage research and developments and to help to make their results known and used.

(7) To continue to act, as we are doing already, though probably to a steadily increasing degree, as a centre for information that is freely available to all.

There is thus a full and important programme before the Society. How it will develop depends on the way the situation in general develops and of the resources—which, of course, means the income—the Society has at its disposal. We all know how we have had to struggle for even the bare

minimum needed to keep the Society alive, and how, although things have improved during the last two or three years, we still have only a fraction (about a fifth) of the income needed to do the work adequately.

It is interesting to reflect that the real reason for this lack of funds is also, fundamentally, the reason for the Society's influence and prestige. It is, simply, our independence.

If the Society were tied to any one particular interest, whether it was commercial, local or central government, or anything else, it would in all probability be much better off, but at the same time much less useful to the clean air cause. Many groups are interested in cleaner air from their own particular standpoint—which may, in itself, be quite a worthy one—but if the Society were to refuse the support of all who had some such interest, it would very quickly cease to exist.

The alternative, which in fact is what has happened, is that the Society should have the membership and support of every kind of interest. From such a broad and balanced membership we have attained a real independence from narrow or sectional interests, and have built up an invaluable forum—as this conference itself demonstrates—where all may express their views, and from which can emerge policies that are practical and effective.

It is not my intention to say a great deal on the Clean Air Bill in this address—there is to be plenty of opportunity for that during this Conference, beginning in a very few minutes. There are, however, one or two observations I should like to make.

The first is that no matter how good the new Act may be in its intentions and provisions, it will not succeed unless it is used with firmness, wisdom and continuity. There is no doubt that it will be so used by many Local Authorities, who are indeed anxious to make much more rapid progress towards cleaner air, but it would be foolish to pretend that there are not others which even today seem to care little about the prevention of smoke. One has only to travel about the country to see instances of smoke emission that reveal both a sorry ignorance on the part of the manufacturers responsible for them, and a serious lack of vigilance on the part of the responsible authorities.

The Local Authorities represented at this Conference are obviously those which take their responsibility seriously—at least I assume that that is so!—and I want you to consider what you should do to bring your more lethargic neighbours into line. Smoke, as we have so often been reminded, knows no boundaries, and I suggest that no question of civic etiquette should stop you from making a fuss about pollution from other areas that affects your own. In some cases, perhaps, the regional smoke abatement committees might act as a clearing house for such mutual gingering-up.

There has been some controversy about one provision of the Bill, which, as the Beaver Report recommended, allows for the more difficult technical pollution problems to be the responsibility of an enlarged corps of Alkali Inspectors. The proposals seem to be most flexible and should give plenty of scope, when the time comes, for discussion and agreement between the Local Authorities and the Minister. I hope that further discussion, especially during this Conference, will not be diverted and bogged down by undue concentration on this point. There is, however, one aspect of the proposed new scheme of things which concerns what I have said about the effective implementation of the Act, and that is the manpower required. The preamble to the Bill mentions an ultimate additional cost for the Alkali Inspectorate of £40,000 a year—which would allow for a score or so of new inspectors. No reference is made to the staff of trained inspectors that the Local Authorities should employ, but it is obvious that to do the work efficiently many more will be needed, and that to obtain the right men—and indeed to reward more adequately the present inspectors—the Local Authorities must be pre-

pared to spend a good deal more money.

The Bill does allow them to spend on research, investigations and propaganda for clean air, and we hope that this may lead to more generous support to this Society, which is anxious to extend its services to its Local Authority members. Part of the publicity needed, I suggest, both by the Society and the Local Authorities themselves, is to show that the increased expenditure needed is well worth while. When we remember that, according to the estimates made by the Beaver Committee, the annual air pollution costs to a town of 50,000 is something like half a million pounds, and so on in proportion, it is not being extravagant to urge the expenditure of five, ten or even twenty thousand a year on its prevention. We have got to get it into our minds, as well as into the minds of the public, that it will pay to tackle air pollution on a scale commensurate with its seriousness.

A further point about the Bill is about the one form of air pollution that is excluded from it—that caused by road vehicles, and particularly that due to diesel engines. This omission is due to the fact that the Road Traffic Act, and regulations under it, are considered to be adequate. That may be so, but here we have an excellent example of what I have just been saying—that an Act is of little value unless it is fully used. The Road Traffic regulations, which are the concern of the police, are rarely implemented, despite the obvious and indeed alarming growth of this particular kind of pollution. If we are to secure a substantial abatement of the unnecessary fumes and smoke from badly adjusted or badly operated vehicles—particularly from the older types of petrol-driven car and from all kinds of diesel vehicles (which perhaps need something new in design)—then either the present regulations must be more energetically used or they must be replaced by something better. The police, we all know, already have their hands pretty full controlling the vast, and still growing swarms of traffic that today congest our roads so acutely, but it should not be difficult, or asking too much, for them to be more active and aggressive in this matter.

According to a letter in the *Manchester Guardian* recently, some police forces are in fact taking cases to the courts, but the writer—a police inspector in a Lancashire town—complains that they are never reported in the local press. As publicity about this problem, to build up public opinion, is of the greatest importance, I would like to take this opportunity of appealing to the Press, both national and local, to report proceedings of this nature whenever they can.

I drew attention to this problem at some length in my Presidential Address at Scarborough last year, but make no apology for returning to it today, particularly as the menace is visibly becoming more and more serious, as I saw personally during a recent journey by road from the south of Scotland and back. It is curious that road users in general do not protest more forcibly, but then this is simply one more aspect of the carelessness with which we pollute the atmosphere and the apathy with which we suffer the consequences. In fact, the way we pollute the air with smoke and fumes is largely due to the same habits of mind that cause us so disgracefully to litter our streets and parks, and the places that once could be called beauty spots, with masses of paper, tins and bottles. The British seem to be supreme at fouling their own nest with every means that is available to them.

In my address to you last year I spoke of the crisis, or revolution in the use of fuel, and our attitude towards it, that is now in progress. That crisis has recently become more acute and difficult. Coal production is falling, and we are having to import foreign coal at great expense, so that all the coal we use, and all its derivatives, have become dearer. Some radically minded people in the past have urged that the price of coal should be drastically raised in order to en-

force its more efficient use—a policy that never won very wide support. But now we are finding ourselves forced into it, though for other reasons. If the higher price of fuel does in fact result in it being used more economically, thus materially reducing its consumption, then in the long run dearer fuel may prove to be a blessing in disguise. We must continue to emphasize that smoke prevention and economy in the use of fuel are closely linked together. The Clean Air Act will not only help to give us cleaner air, but will help to lessen the severity of the fuel supply difficulties that are looming up more and more threateningly.

"Any Questions" on the Clean Air Bill

Panel: The Rt. Hon. Alfred Robens, M.P., and Mr. Gerald Nabarro, M.P.

Chairman: The President, Sir Ernest Smith, C.B.E.

The Rt. Hon. Alfred Robens, M.P., in an introductory statement, said:

Ladies and Gentlemen, it is a very great pleasure to have the opportunity of coming to this conference, and to be subjected later, Mr. Nabarro and I, to some questions. This is rather the boot on the other foot for me, because I used to be interrogated a good deal in a certain place on matters in relation to coal. Now I have the opportunity of putting the questions, and have had for some years, to the other chap. Today we are reversing it, and you have the chance to ask the questions all over again.

When Mr. Nabarro was fortunate enough to win a place in the ballot for a Bill and decided to introduce his Clean Air Bill, and he approached me and asked me if I would be one of his sponsors, I said "Yes" immediately, and we both went into the matter because we felt that this was not political, but a matter of a clean England, a clean air, a better race, and better for the community as a whole. I would not for the world tell you a good deal of the background of his Clean Air Bill—it would embarrass Mr. Nabarro anyway—but I will tell you that he had to have a good deal of courage to go forward with that Bill. I know a lot of pressures were put upon him to perhaps have another kind of Bill and not that one. He went on with it, and I was very glad to have the opportunity of assisting him, and even at the last moment our information was that we would not get the blessing of "the Powers that Be." But such was the array of force that we had in the House of Commons—and it just shows how good a democracy can be—such was the array of all party force that as the time came for the vote to be taken, at the very last moment, there was a change from the opening speech and we received Government blessing. And I say without fear of contradiction that if Gerald Nabarro had not produced a Private Member's Bill for Clean Air, I doubt very much indeed that we should have had the Government measure that we now have, and which we welcome so much.

We shall approach this Bill in the same objective way in which we approached the original Bill of Mr. Nabarro. We want to make it a good Bill, we want to make it practicable and effective, so that it can come into operation at the earliest possible moment and we can begin to do what we ought to have done twenty or thirty years ago, and make a real start to clearing the air of pollution in this country. There is a very good body of people in the House of Commons, of all parties, who want to stimulate local authorities to take the action under the Bill, using the authority that they will have, so that as the years go around we can emulate what has been done in many places in the United States, Pittsburgh and St. Louis for example, where they had a tremendous problem of smoke pollution, and which today are clean, fine cities, although they are, in fact, big

industrial cities. I am sure that generations to come will bless the day when we started forward, vigorously clearing Britain's air from the pollution from which we have suffered ever since the industrial revolution. I think that this organization itself has done a tremendous amount of work to focus public opinion upon the evils of smoke pollution. We in the House of Commons have received from the officials of the Society tremendous help and technical advice when we have necessarily wanted it in dealing with the problems of smoke pollution in the House of Commons, and I would like, Mr. President, therefore to take this opportunity of paying my appreciation to the Society and to its officials who have so willingly given us so much help of a technical nature from time to time.

Mr. Chairman and Ladies and Gentlemen, may I say once again what a pleasure it is to be here at this opening session to talk to you as politicians on this matter of smoke pollution and the part we must play, and to be associated with my friend Gerald Nabarro, to whom I think we owe a great deal for the courageous way in which he tackled this job when he got the opportunity. Thank you very much.

Mr. Gerald Nabarro, M.P., in an introductory statement, said:

Mr. President, Your Worship, Mr. Alfred Robens, Ladies and Gentlemen, I am indebted to my Parliamentary colleague and political enemy, Alfred Robens, for his kind words this morning, and may I say as a measure of reciprocity that the Conservatives associated with me in the House of Commons could not have forced the hand of Her Majesty's Government last February had it not been for Mr. Alfred Robens and five Socialist Members with him, who sponsored my Bill, and thereby assured me of almost complete Opposition support that the Government should bow to the will of the Parliamentary majority.

Today, Sir, it would be appropriate at the outset if I made reference to Sir Hugh Beaver. Our Bill last February and the Government's Bill today, most largely spring, of course, from the eminently readable Beaver Report published by Sir Hugh and his Committee, and submitted to the Government in November, 1954. I say eminently readable because it is one of the first Government Reports that I have ever scrutinized that really gave me pleasure to read and which demonstrated easily and readily the purposes and objectives of his Committee. The Government Bill has now appeared. I am not very satisfied with it, I may say. It is—and I have no doubt that these criticisms will be brought out in our deliberations later this morning—it is much too leisurely, it allows of much too much escapism, and it is not sufficiently objective for its purpose. A wag called it recently "a partial clean air bill," and I think the enthusiasts gathered with me in this hall this morning will join with me in saying that we want complete purification of the atmosphere within the next few years, and not only partial progress towards a laudable objective. There is though, Mr. President, a much more vital and dynamic requirement in connection with this Bill. You made the passing reference to imports of coal, and I want to say just a few words about the coal position, and very shortly, for I fear that it is not yet sufficiently understood by the great mass of our people.

The coal situation is more critical than it has ever been. We are importing this year no less than twelve million tons of coal at a cost of eighty million pounds. Most of the economic difficulties that the Government has this year spring from the need to use large and growing resources for the import of fuel, be it coal or be it oil. What generally escapes the attention of the masses of people is the fact that the import of oil is nearly as serious as the import of coal, and has the same adverse effect on our financial balance of overseas payments. It

is not much use, in my view, Mr. President, and has not much validity, to say that the coal miners ought to work harder. What ought to work harder is the coal that they produce; and it will be evident to all interested in this problem that there is still prodigious waste of coal by British industry. The concomitant of the waste of coal by industrial furnaces is the creation of dark and black smoke. Mr. Alfred Robens and myself have agreed over many years that Parliament finds it very difficult to legislate for fuel efficiency. The only way that fuel efficiency can be induced by legislative measures is by an attack on dark and black smoke, and it is the industrial smoke which is the dark and black smoke. Do not imagine, Ladies and Gentlemen, that by attacking the domestic chimney we are going to save very much coal; on the contrary, the dark and the black smoke is industrial smoke; domestic smoke is rarely or never dark or black. And the third point to which your President rightly drew your attention—the special processes and fumes, the Alkali Inspectors' responsibilities—is certainly an important matter, but it is nothing like so important as the saving of coal in order to minimize imports and thereby help out national economy.

I set before you, therefore, the objectives of my words this morning. I set before you three distinct priorities in connection with the Government's Clean Air Bill.

The first of those priorities is the attack upon industrial smoke; the attack upon dark and black smoke in order to raise fuel-burning standards in industry. The second is the extension of what the Bill now calls Smoke Control Areas—I much prefer, Mr. President, your well-known and homely phrase, the Smokeless Zone—which will form the attack upon the domestic chimney. The third priority, and the most intractable of all, is the emission of noxious fumes by what Sir Hugh Beaver called special processes, and which will be the responsibility of the Alkali Inspectors.

Before I sit down I want to make this one fundamental point which I hope will be taken up later in our discussion. I said that the Bill was too leisurely. I said that it allowed of too much escapism. I personally see, writ large between the lines of this Bill, the hand of the Federation of British Industries, and I am an employer, I am a Tory, and I am a member of the F.B.I. They have, with their colleagues, evidently persuaded Ministerial circles to allow escape routes for the recalcitrant industrial chimney owner. If one example of that is needed—I hope it will be brought out later this morning—Clause 1 of the Bill prohibits dark smoke from chimneys, and then goes on to say, in effect, that it will always be a defence to plead that the fuel used was unsuitable in the boilerhouse. Mr. President, in my view that will allow every recalcitrant industrial chimney owner to get away with it almost in perpetuity. Any solid fuel, including almost the lowest grade of coal, may be burned in an industrial boilerhouse provided that the equipment is good and right and suitable; provided that there is an efficient mechanical stoker; provided that the primary and secondary draughts are correct; provided there is a skilled fireman in attendance; provided the thermostatic control in the boilerhouse is correct; provided as a precautionary measure that there are appropriate smoke recording and alarm instruments. Therefore, there should be no escape in my view for unsuitable fuel so far as industrial smoke is concerned. We cannot allow that to go through the House of Commons, and I personally shall oppose it strongly. If we allow it to go through it will vitiate the Bill and make the task of all the administrators of the measure, principally the local authority officials, immeasurably more difficult.

I wind up on this note, Sir. A hundred and seventeen years ago in the City of Glasgow the Death Carts rumbled over the cobbled streets. The cry was heard "Bring out your dead." They were in the midst of one of the worst cholera epidemics

known in this country. It sprang from polluted and dirty water. In a hundred years Britain's water system has become the envy of the whole world. I do not drink tap water in France or Italy. Nor do you, if you are wise. Ask yourselves why you don't, and why you drink such tap water in Britain with perfect equanimity. We succeeded in that field in a century. I hope that, with the help of all my Parliamentary colleagues, be they members of the Socialist Party, the Liberal Party or the Conservative Party, we shall achieve a similar measure of success in the field of clean air and purification of our atmosphere in markedly less than one hundred years, and, in fact, within a period of ten to fifteen years only.

The Chairman then called for the questions (printed in italics).

Dr. Martine, Chairman of the Executive Committee: Will the members of the Panel agree to seek to have included in the Bill a provision requiring that all stokers of hand-fired furnaces should in due course be trained and certificated?

Mr. Robens: I think that that is a very admirable suggestion and one that, if written into the Bill, could be of enormous advantage. We have so many times said, in the House of Commons and elsewhere, that the untrained stoker can waste the labour of many miners and at the same time, of course, he is adding to air pollution. I know that, along with Sir Ernest and many others, we have tried our best to encourage industry to use only trained stokers. Courses have been arranged at various technical colleges throughout the country, and we have, as a rule, done our best to encourage, by voluntary means, individuals to do the thing which is in the public interest. Now I myself agree with the approach, in our system of society, that we should try and get people voluntarily to do these things; that is very much better than forcing them to do it by legislation. At the same time, if a very large number of people, industrialists and others, have trained stokers, it is unfair that they should then have to suffer with the rest from the pollution of the atmosphere because a minority of people simply will not do this job of training stokers and employing trained stokers. We hoped also that the special courses for training of stokers might be met by the appropriate grade of wage for trained stokers against untrained stokers. I have come to the conclusion that we have now been going for so many years that we have reached the stage when it is quite fair and not unjust to anybody to say that as from a given date, only a trained stoker ought to be in charge of a hand-fired furnace.

Mr. Nabarro: I am entirely in agreement with Mr. Robens about this. In Canada, in the United States of America, in Australia and in Western Germany, suitable provisions ensure that no unskilled man may be employed in an industrial boilerhouse, and in many countries overseas, certificated boilermen are essential by law. Now in this country, we are certainly training boilermen by voluntary measures, as Alfred Robens says, but let me put it into its correct perspective. Last year we trained, through the varied media available, 650 industrial boilermen up to a minimum standard of proficiency. 650 out of an estimated 75,000 boilermen employed in industry! If we go on at the present rate it will therefore take something in the order of a 100 to 110 years before they are all qualified. I believe that by legislation the time has now come when we should require that from a given date two to three years hence, a reasonable period allowed to elapse, a boilerman should be required to have reached a minimum standard of proficiency. Let me epitomize what I am saying in these few words: an unskilled boilerman in industry can waste in one day more coal than the most highly skilled miner can hew at the face. In present

economic conditions can we allow that state of affairs to continue and remain resting on voluntary effort alone? I think not.

The Society, in its memorandum to the Beaver Committee, urged that the new legislation should require local authorities to employ an adequate trained staff for smoke prevention. The Beaver Report urged that local authorities should submit annual reports on their smoke prevention activities. Will the members of the Panel press for the inclusion of these two provisions in the Bill?

Mr. Nabarro: I propose, Mr. President, to move an amendment on the Committee stage of the Bill to require that all local authorities shall report to the Minister of Housing and Local Government, being the responsible Minister, once a year on the progress that they have made towards implementing the provisions of this Bill.

Mr. Robens: If Mr. Nabarro moves that I will be very glad to second it.

In smoke control areas in the U.S.A. the use of unauthorized fuel is prevented by control of the sale of such fuels. Would not such a method be simpler and more effective in this country than control by the observation of chimneys, and especially of domestic chimneys, which are not only numerous but emit much of their smoke after dark?

Mr. Robens: I am not sure that we can adopt the American pattern here, however desirable it may appear to be on the surface. I spent some time in Pittsburgh, particularly studying this question of the way in which they have dealt with smoke, and it really must be remembered that in Pittsburgh they have available—by, of course, pumping it over considerable distances—almost unlimited supplies of natural gas, and in the main, the bulk of their heating load is now taken by natural gas. Indeed, it is very rare to find in any domestic home any solid fuel being used at all. The use of that natural gas is something that is denied to us here because, despite the very large sums of money being spent upon exploration, we just have not got either oil or natural gas available. The Gas Council is spending, as you know, £1,000,000 in furthering the Darcy Exploration Company's operations to see whether or not there is natural gas in commercial quantities available. The fact that we have neither the oil nor the natural gas at our feet does mean that we have to try and achieve what the Americans have achieved in Pittsburgh by another way, and I myself do not consider that the control of the sale of solid fuel would be the best way to do that. I think that what we ought to aim at as a goal—and I admit that it is very long term—is to make it illegal to use or burn raw coal at all in any circumstances. If it were possible to coke all our coal and use the solid fuel either in the form of a manufactured sort of smokeless coal or gas or in any other way, then we should solve this problem of smoke pollution. There are many technical difficulties about that, and many capital difficulties, but the Coal Board should, in my view, press ahead, even more extensively than at present, in finding the blends of coals that will make something similar to the Phurnacite that is made in South Wales. The more smokeless fuel that is made and sold, obviously the less our smoke pollution problem is. So I would say that we cannot very well do this task by concentrating on controlling the sale. Let it go much further back than that; let us control the raw material and say to the N.C.B. that whilst we appreciate all the efforts they are making—and they have been very great efforts to produce a smokeless fuel from the coal that they mine—this must be done at a greater pace.

Mr. Nabarro: That is a very excellent answer, Mr. Robens, if I may say so. I want to add a little to it by way of comparison between American arrangements and our own arrangements in the United Kingdom. In the United States of America today only 40 per

cent. of the aggregate fuel and power requirements of the American nation are supplied by coal. In this country the supply of coal can be controlled at the source through the National Coal Board entirely. Let me try and put the matter in its correct perspective by the use of figures—very simple figures. The output of Phurnacite today by the National Coal Board is only four hundred thousand tons per annum. The output of proprietary solid smokeless fuels, other than those produced by the Coal Board, is of the order of a million tons per annum excluding coke. Quite clearly, in the next few years, if the Clean Air Policy is to be pursued, vast additional quantities of smokeless fuel will be required commensurate with the expansion of the smoke control areas, or, as I prefer to call them, smokeless zones. I believe, and maybe I risk coming into political collision here with Alfred Robens—though I think he can stand it—I believe that the Coal Board should not have the monopoly of producing solid, smokeless fuel. They have their Phurnacite process, but there are a number of private firms producing fuel comparable to, if not better than, Phurnacite manufactured by the Coal Board. But the thing that is holding up the expansion of the processes of private firms is that the supply of their primary product, namely, the coal to turn into smokeless fuel, is controlled by a state monopoly that have their own interest in producing Phurnacite, and those private firms are therefore a little reticent to put large additional sums of capital into the expansion of their own private processes when at one stroke their raw material supply, namely, the coal, could be cut off by the state monopoly. If, therefore, we are to get adequate solid smokeless fuels it is in my view essential that the Government should assure those private firms that if they put large additional sums of capital in the expansion of their processes, then the supply of their basic raw material, namely, the coal from the pits, shall be adequate in quantity over a period of years ahead. That is a critical factor in my view in supporting the provisions of this Bill.

Mr. Robens: May I beg to make one small point, and that is this—I thought Gerald Nabarro was going to be really controversial, as he is so many times in the House, but I would not myself say that the Coal Board should have a monopoly of making smokeless fuel. Their main task and their main preoccupation ought to be digging more coal, because so much more is required but they will have to do a lot of research on the blending of coal, because all coals from source are not particularly suitable for making into a smokeless fuel, and therefore I think initially they will have to assist private enterprise, which is doing a very good job of making smokeless fuel. They will have to assist them in giving them the right blends of coal in order that they can make their product, and that is a Coal Board task and the—I was going to mention a firm there, but I must not advertise (a little bit like commercial television, isn't it?). There are many of these industrialists who make smokeless fuel who could expand if they could get the right blend of coal. Therefore, it does seem to me that it does come back to the Coal Board to provide the blends, and it also means that the Government must help those other industrialists who are exploiting new processes and are finding it extremely difficult to get the capital for this risky investment, which is so essential if they are to continue their research. Therefore, there is not a great deal between Gerald Nabarro and myself, except that I think it is a primary task of the Coal Board to supply the right blend of coal to those people making smokeless fuel in the quantities they need.

The Chairman, Sir Ernest Smith, said: I hesitate to intervene in a matter like this, but I do feel that both of our speakers are not accepting the necessity for immediate developments and the process of graduality and evolution. Public opinion has got to be behind

this, but I cannot help but feel that if we were to press for equipment to be supplied even to the domestic consumer, to provide for the possibility of using coal with less smoke, it would be better than going for a hundred per cent. smokelessness immediately, or at some distant time. There is equipment that does produce less smoke; there is even equipment attached to gas and electrical combinations, and so on. I am going to make one point that I think is being overlooked. Just as we are worrying about smokeless zones, I believe that the young people of today are becoming more civilized, and that when they grow up they will refuse, in twenty or thirty years' time, to use solid fuel at all. Today the argument is that electricity and gas cost too much, but the dropping of one or two cigarettes a day would pay for the whole difference in the use of gas or electricity compared with solid fuel. Do you think these girls in the future are going to be prepared to go about picking up hods of coke, getting dirty, dusty houses and the like? That is only the future, but in the meantime we have to use coal and to go to enormous expense in building equipment that will produce all the solid fuel we want by expensive methods of blending, which is going to mean the expenditure of capital which need not be used. Forgive me for this.

Alderman W. E. Yorke, Sheffield, Rotherham and District Smoke Abatement Committee: In view of the fact that the Association of Municipal Corporations has submitted a memorandum to the Ministry on behalf of its 420 *local authority members on the Beaver Report, and in particular reference to the transfer of certain scheduled processes to the Alkali Inspectorate, do they not feel that the appropriate paragraph in Mr. Nabarro's Bill should be inserted in the Government Bill in order to give appropriate powers in this connection for these authorities or groups of authorities which can qualify to undertake this responsibility?*

Mr. Nabarro: The questioner very kindly referred to an essential difference between the private Bill supported by Alfred Robens and presented by myself in Parliament last February, and the appropriate provision in the Government's Clean Air Bill. The Government's Clean Air Bill follows slavishly the recommendations of the Beaver Committee in this regard, namely that these special processes mostly concerned with the emission of noxious fumes from carbonization works, from chemical works, power stations and so on, should rest solely within the powers of the Alkali Inspectorate as at present, but that the Alkali Inspectorate should be expanded appropriately and that further processes should be added, if necessary, by Ministerial order. I said, last February, that I preferred a compromise solution. I said that in the Bill, in the instance of the big local authorities, for example London, Cardiff, Birmingham, Manchester, Sheffield, Liverpool, Coventry, Newcastle, Glasgow, Stoke-on-Trent, and so on, where they could demonstrate satisfactorily to the Minister that they had the technical resources and staff available for the control of these special processes, such authorities should have complete autonomy; they should, in other words, govern these processes in the same way as they will govern the emission of dark and other smoke from industrial chimneys. There is a very great difference in Britain. We must recognize that the Little Piddlecombe-on-the-Marsh Rural District Council, with its total of, say, three permanent officials and perhaps fifteen hundred local residents spread over a wide area, clearly could never have the technical resources or staff available for the control of special processes of this kind, if there happened to be a works in its area which was causing a nuisance and injury to health by the emission of these fumes. But, such an authority is not to be compared, for the sake of example, with the City of Manchester, or with the City of Sheffield or such other large local authorities and, therefore, I

still favour my compromise solution. It is very simply expressed, that where a big local authority can demonstrate to the satisfaction of the Minister that it has the technical resources and staff available to govern these special processes in fume emission, as in the case of smoke emission, then complete autonomy should be given to that authority so to do, and it should be permitted to draw upon the expert and scientific advice of the Alkali Inspectorate in London but only in the form of advice as necessary. Other smaller local authorities, not in a position to demonstrate in that fashion to the Minister, would, of course, have a divided control. The local authority would control smoke, and the Alkali Inspectorate would control fume emissions from special processes. I believe that to be an effective and practicable compromise, and am quite sure that nearly all the big local authorities in the country—this is critical—are identifiable with the Black Areas of the Beaver Committee's Report. I think those big local authorities should govern themselves. Clean air, Mr. President, is indivisible. The gentlemen in Whitehall will not know best what is for the good of the health of the residents of Manchester, Glasgow, London or elsewhere; let the local authority do that job.

Mr. Robens: I must briefly say I am not one of those people who subscribe to the idea that the gentlemen in Whitehall knows best. As an old local authority man, I am always jealous of the rights of local authorities, and I believe that where they can adequately do the task, they should do it, because they have their elected representatives from the people they control. It seems to me a much more sensible thing that elected representatives of the people in their locality should run their locality. It seems, therefore, that my answer to the question is on the same lines as Mr. Nabarro's, that where the local authority is equipped to do this full task, then they should be entitled to do it as part of their work.

Alderman W. E. Yorke: With regard to Section 5 of the Bill relating to grit and dust from furnaces, is information available as to the number of furnaces in the country which burn 10 tons of solid fuel per hour or more in order to be required to fit plant to arrest grit and dust, and is the number of such furnaces very few?

Mr. Robens: I do not know the figures myself, but I should say that the number of plants burning ten tons an hour is known, because at the time there was the coal allocation the Minister of Fuel and Power had to have such information. Therefore I should say the information is known or very largely known, and it would not take a great deal of trouble to make a complete survey.

Mr. Cass, Oldham: What economic incentive is there for industry to effect abatement of smoke nuisances in the Clean Air Bill?

Mr. Nabarro: I said earlier this morning that the concomitant of the faulty and inefficient burning of coal in industrial boilerhouses was the creation of dark and black smoke. I also said that one could hardly attack inefficiency in the burning of coal legislatively except through an attack on dark and black smoke. This was recognized many years ago in the House of Commons. I think I may claim, with due modesty, to be the first Member of Parliament who has ever talked about coal in the middle of a Finance Bill, and that took place in the summer of 1951. Alfred Robens' party was in power, and the Chancellor of the Exchequer was an ex-Minister of Fuel and Power, Mr. Hugh Gaitskell. I pleaded for the retention of a 40 per cent. initial allowance on certain classes of fuel economizing equipment in industry. Mr. Gaitskell said " no." We took it to a division, and my Conservative friends and myself were defeated by eight votes. Two years later, with the Conservative party in power, a Labour back

bencher, Mr. Anthony Crosland, moved a similar amendment from the Opposition Side of the House, and the Conservative Chancellor said " no." The same men who got up and supported me from the Opposition Benches two years earlier then trooped into the Lobby under the powerful influences of the Chief Whip and voted against what I was advocating.

Most of you have been kind enough to write to me about a book I wrote three or four years ago called " Ten Steps to Power: a National Fuel and Power Policy." It contains precisely this recommendation for an adequate fiscal or tax incentive for the replacement of industrial plant in order to induce greater coal burning efficiency. Ridley, in his somewhat ineffectual report, sidestepped the issue; Beaver did not. Beaver said this—" Consideration should be given to allowing the whole of the capital cost of new plant and equipment installed to save fuel and to prevent smoke to be charged against revenue for tax purposes in the year in which the expenditure is incurred." I recently had a quarrel with the Minister of Fuel and Power when in a speech in the House of Commons I again raised this issue only a few weeks ago, in July, 1955. I was again told by the Government spokesman, winding up, that it would be wrong to create differences as between taxpayer and taxpayer. And it seemed to be a ridiculous answer. I shall return to this matter again at an early date, and I hope next time the Chief Whip will be sufficiently lenient to allow me to vote against the Government if the Treasury will not give in. I can at least be assured of the active support of Alfred Robens. He's not wearing his " Gor' Blimey " cloth cap this morning, but I'm not the only culprit; he has turned his cloth cap round twice in recent years. He voted with his side in 1951 against the proposal; two years later he voted with his side for the proposal. I hope next time, Mr. Robens, we may both vote for the proposal, particularly in view of what Beaver said, and I reiterate that the greatest incentive that may be given to industrial fuel efficiency, and therefore the elimination of dark and black smoke, is by a fiscal incentive to industrialists, of the kind that I have been advocating this morning.

Mr. Robens: I would be delighted to vote with Gerald Nabarro any time if it would bring down the Government. This discourse on how politicians vote and why has been most interesting, but I think there is little enough time left to me—there is only an hour and ten minutes—to explain why it is all done. It makes it quite impossible for the foreigner to understand how we run Parliament. But seriously, I think he is right on this initial allowance question. It is surprising the effect that Treasury officials have upon the Government in power, and as most people here are from local authorities, they have had enough experience of the Treasurer's hand or that of the Chairman of the Finance Committee, and I need not explain any more about it.

Alderman Mrs. J. Engwell, Barking: How will the Government ensure an adequate supply of smokeless fuels in the " black areas " without special powers in the Clean Air Bill, and is it considered desirable to terminate contracts for the export of coke?

Mr. Nabarro: Let me make three very short points in response to this question, Mr. President. The first is that it does not require legislation to increase supply of solid smokeless fuel; that is an administrative act within the existing powers of the Minister of Fuel and Power working in conjunction with those nationalized industries that produce smokeless fuel, namely, the National Coal Board, the Gas Boards and the Electricity Boards, all of which contribute to smokeless fuel supply. Therefore it is not necessary to write it into this Bill. The second point is—let there be no mistake about this at all—we are not suddenly, when the Bill goes through Parliament, to wake up the next morning and find

that the whole country is one big smokeless zone. That is what all my correspondents, who write to me about this matter, evidently anticipate. What is going to happen is that by Ministerial Order under the appropriate clause of this Bill, new smokeless zones, or as they are called, smoke control areas, will be created, as you call it, Mr. President, by the process of graduality. But the Minister will only create such zones by Ministerial Order having satisfied himself of the expansion of smokeless fuel supply, commensurate with the rate of expansion of the zones. I think that is very, very important. Is it desirable to terminate contracts for the export of coke? We are exporting so little coke today, in comparison with the production of coke, that it would not make any significant difference.

Alderman Mrs. J. Engwell: The Bill allows a period of seven years in which fuel burning installations can be improved or replaced. Does the panel agree that at the same time the Bill should require the installation on the control panel of every boiler of some form of smoke recorder correlated to a statutory standard of emission, so as to avoid smoke observations by local authority officers?

Sir Ernest Smith: I take it this means the need for taking smoke observations.

Mr. Robens: I do not think that even if you have recording instruments on the boiler it would obviate the necessity for the observation. You may have excellent recorders in the boilerhouse, but if, of course, no notice is taken of what they are recording, there can still be black smoke coming from the chimney. Even with all the mechanical aids to enable the stoker to be sure that he is not making black smoke, it seems to me that you really must have your inspectors for observation in order to ensure that those instruments are being properly taken care of and regarded. After all, we make breaking into a house an illegal offence because it should not be done, but we still have to have a policeman to make sure that it is not done.

Mr. Nabarro: That is a very good answer indeed, and observation will still be necessary, but I do feel, as I said in the House of Commons on the 4th February last, that good boilerhouse practice and smokelessness are greatly aided by the provision of smoke recorders and alarms, and it is not as if a large sum of money is involved. Those instruments cost very little money, according to their size, of course; but before the private Bill last February, manufacturers of this equipment came to me and asked me what was the possibility of making it a statutory requirement that there should be these instruments. I was very non-committal, though I agreed it was desirable, because obviously there was a vested interest. I am not sure whether it should be written into the Bill, but I propose to bring it out at the Committee stage, when it may be discussed by all political parties in the House of Commons, to see whether it is desirable actually to write it into the Government's Bill.

Sir Ernest Smith: Surely if authority is going to be vested in some particular body, locally, whether it be an industrialist, or whether it be a local authority, to regulate every detail as to how that authority should be exercised is going to relieve him of too much responsibility, and it would be very much better to say " the responsibility is with you to see there is no smoke, now prove it," rather than make it so easy for him to say " well, I had a smoke indicator, and it says so and so, therefore you're wrong "—it may not be working. Look at the CO_2 recorders that are used in so many places but are never right.

Councillor A. Tinkler, Rotherham Rural District Council. Why go to the trouble, time and expense of promoting a Clean Air Bill when persons living in industrial areas will see little or no change? The reasons being that the avenues of escapism are too wide and too many.

Mr. Robens: I think that Gerald Nabarro dealt with this particular question in the first remarks he made, in which he said that there were too many escape routes within this Bill, and I think that is right. After all, Parliamentary procedure provides especially for a very careful examination of any Bill, and I myself know of no occasion when any Bill produced by any Government reaches the Statute Book in exactly the same form in which it is presented. It is one of the great undoubted attributes of our democracy that Parliament is able and permitted to get down to the basis of argument and discussion, mainly constructive, on a Bill of this kind, in order to produce the best law from the Bill that is at first produced by the Government. We shall certainly examine this question of the escape routes very carefully indeed, otherwise I would agree with the questioner—there is no real point in having the Bill with so many exceptions that it does not work. What we want is a Bill that will work, and therefore our attention will have to be devoted to what is possible and practicable. It would be just as foolish to produce a Bill that was not practicable or possible, and therefore we will consider this extremely carefully in Committee. We shall have the benefit of great expert advice from all parts of industry, so that we can have a Bill with as few escape routes as possible, and yet nevertheless have a Bill that is possible, practicable, and can be effective in the shortest possible time.

Mr. Nabarro: I agree with what Alfred Robens has said, and there is, of course, a note of cynicism about the question. It says in effect, what is the good of any social legislation, because nothing ever happens? Well, I believe something does happen, although it often takes a few years for it to happen. The critical thing about this Bill (Clause 1), is, I think, the greatest offender. It does provide, Clause 1—which is a prohibition of dark smoke—that *in extremis*—I count my words very carefully—a recalcitrant industrialist, producing dark or black smoke, can get away with it for seven years, and that seven years, Mr. President, is in my view much too long. It ought to be, in my view, three years, and one of the first amendments that I shall seek to this Bill on Clause 1 is the fact that the period is too long. I shall seek a reduction of it to three years, if I finish up with a compromise of five years, at least it will be better than the seven years in the Bill.

Mr. R. Williams, Chief Sanitary Inspector, Coventry: In the present clauses the Bill anticipates that smoke density will be measured by the use of Ringelmann's charts over a period of up to four hours. This is a two-man operation, and is likely to be most conspicuous when being carried out. Would the Members of Parliament be prepared to support that investigations should be made into the possibility of developing an optical smoke density measurement comparator to be used in this connexion? Such a comparator could be graduated in accordance with the Ringelmann's chart numbers, so that the calibration agreed.

Mr. Nabarro: The greatest objection to any clean air legislation has always been the difficulty of measurement and identification. What is dark smoke? What is black smoke? Many of you may have read an admirable report written by the Anglo-American Productivity Team which visited the United States of America and reported two years ago on fuel conservation. They brought out this point very well. They said that in England a recalcitrant—I use the word once again—industrial chimney owner could always get away with it, if, of course, he had a good enough lawyer, simply by creating grave doubt as to what is dark and black smoke. There must be a method of identification. In the United States of America the Ringelmann Chart has proved singularly successful, though I am perfectly prepared to admit there may be better methods. If you read the Bill carefully you will see that there are means by

which the Minister can introduce supplementary provisions to require other methods of identifying dark and black smoke in addition to, or *pari passu* with Ringelmann, and I suggest that that is left to Parliament. I suggest that we shall get the cranks—one of my Conservative colleagues got up and poked fun at the Bill last February. He was a lawyer, a local solicitor in the Midlands, who said, " Ringelmann, who's ever heard of Ringelmann? How are we going to be able to prove that the smoke was dark or that it was black? " I suggest that if this Bill goes through, the Minister has plenty of powers to make it operative.

I am not sure what the constitutional position would be when local Acts are superseded by a central Government Act, but as Alfred Robens has said, this is a jolly good point for the lawyers to argue in Committee. Personally, I shall not participate, as I am not a legal luminary, and I think we will find that the powers at present vested in the larger Local Authorities within their smokeless zone legislation are satisfactorily safeguarded.

Commander C. Buist, R.N. (Retd.): Benzol is a by-product made when coke is produced. At present the excise duty on benzol is 1*s.* 4*d. per gallon. Should not the Chancellor of the Exchequer abandon this excise duty so that the price of coke could be reduced accordingly?*

Mr. Robens: I should be delighted if the Chancellor of the Exchequer would abandon a great many duties, but I am compelled to say that when he comes to deal with his Budget, once he has decided which way his taxes will go, there is very little opportunity for Parliament as a whole, backbenchers on either side of the House, to change the general line of the Treasury. Therefore, if in this particular instance it was felt that the abolition of that duty would be an aid to the production of smokeless fuel, it seems to me to be one of those things that have to be argued by the industry with the Treasury. I might give a little word of advice—start the argument at least three months before the preparations for the Budget are in hand.

Mr. Nabarro: I think that it would be very wrong indeed for me to anticipate in any way my Rt. Hon. Friend, the Chancellor of the Exchequer's 1956 budget.

Dr. C. O. S. Blyth Brooke, Medical Officer of Health, Finsbury: Will consideration be given to strengthening the powers of local authorities under Section 19 *of the Clean Air Bill to control nuisances arising in smoke controlled areas from the burning of industrial waste on bonfires or incinerators without a chimney, and the burning of bonfires in gardens and parks during the autumn when meteorological conditions are such as to hinder the dispersion of the smoke, although in other cases it may be difficult to prove actual nuisance to the inhabitants of the neighbourhood?*

Mr. Nabarro: I am flat against getting down to parish politics in a measure of this kind. Please do not involve me as a politician in the case of Mrs. Snook's bonfire down the road. That sort of thing may cause a local nuisance, but it is surely not the sort of thing that you should ask a Government to deal with. It ought to be done by means of local authority byelaws.

Mr. Robens: The question says " during the autumn when meteorological conditions are difficult," and I see there is a real point there. Nuisance from burning must be a problem that many local authorities have. It is not just bonfires; it is the scrap merchant, who is perhaps dismantling cars and wants to burn some tyres and things of that kind. The associations of municipal authorities may be giving us some advice about this. They might have a look at this particular point about the local nuisance, and whether it would be effective within this Bill. If they would consider that and let us have their views about it, we would be only too ready to help and to give local authorities the sort of powers they need to look after their locality effectively and properly.

Mr. A. M. O'Hanlon, Sanitary Inspector, High Wycombe: How would the panel deal with a vessel which is not in waters, i.e., in dry dock?

Mr. Nabarro: I think the answer to that is to approach the Chamber of Shipping to make their representations to Parliament about it. Personally I am rather sorry that the scope of this Government Bill has been made so wide as to try and include such items as ships in harbour, railway locomotives, and so on. I think it is difficult to legislate to prohibit a puff-puff from puffing. I think it is equally difficult to legislate to prevent a steamer, when coming into the Port of London, causing a certain amount of smoke. It is temporary anyway, and those items are only incidental to the main theme and the principal priorities —industrial dark smoke, one; domestic smoke, two; special processes, three; which I outlined to you when I was privileged to speak at the beginning of this meeting. I think it would be a mistake to try and focus attention on matters of that kind, which, in any event, are largely administrative in character, and I do not think that one ought to try and write them into a central Government measure of this kind.

Dr. C. F. Lynch, Medical Officer of Health, Dover: It seems to me that one of the main difficulties is likely to be the proviso of "practicability" contained in several clauses of the Bill. For example, what effective steps can be advised in the case of serious pollution of the atmosphere from a blast furnace of modern design when the cause is believed to be the inferior type of scrap iron received and to a lesser extent the inferior coke fuel, both of which it is pleaded are unavoidable, and when such additional preventive measures as gas washing or much higher stacks are rejected as uneconomic and impracticable?

Mr. Nabarro: The President has just whispered to me they do not put scrap iron in a blast furnace. There may be something in that, but this question, of course, is directed against the scheduled processes listed in the Beaver Report, and which form the subject of Clause 13 of the Government's Bill. I referred to the Alkali Inspectorate earlier and whether they ought to have complete autonomy or whether the bigger local authorities ought to govern themselves. I do remind the questioner and the audience that, under the conditions of the Government's Bill, the Minister has powers to add to those processes. Now, if the processes referred to in this question are not already contained within the Bill, then the Minister can add such a process to those already listed, which seems to me to be the proper recourse. I do not think that it is legislatively practicable to list in a Government Bill dozens and dozens of individual technical processes in a wide range of industries. That is not the purpose of Parliament. Parliament delegates authority and responsibilities to the local authorities, to the Alkali Inspectorate and so on, and there is a Minister answerable in Parliament for all of the processes concerned, and it is much better to leave it on that generic basis rather than to seek to particularize with individual specialized processes.

Mr. T. Williams, Chief Sanitary Inspector, Bolton: We have in Bolton at least 24 *old age pensioners in the smokeless zone. When it comes to the cost of converting a dwelling house, usually at low rent, to complete smokelessness, the estimate of the Beaver Committee of* £10 *is quite unrealistic. It is in fact nearer to* £25 *or sometimes* £30. *How can the difference between the* 70 *per cent. from Central and Local Government funds be bridged when that* 30 *per cent. presumably is to be found by the occupier? Now, lest someone should say that the owner can do it and that there is the right to appeal to a court, I would say our experience is that an old age pensioner is usually, because he is in the evening of his life, unwilling to go to court, and is usually not sufficiently* au fait *with legal procedure*

despite advice, to take action via the court.

Mr. Nabarro: I will reply very briefly to this admirable point, and I am grateful to Mr. Williams for raising it. The position is that under the Bill 70 per cent. can be provided from public funds, leaving 30 per cent. If the cost of the replacement appliance is therefore, for the sake of example, £15, or the cost of conversion is £15, £4 10s. 0d. does fall on sources other than the authorities. In certain cases, a small minority, it will be difficult for that money to be found. I can only say at this juncture that I have made a note of this point, and when the clause is discussed in Committee at the House I will raise it and endeavour to obtain some satisfaction for you, Mr. Williams, and your colleagues.

Twice within the last three weeks Mr. Nabarro has spoken about the influence exercised in the preparation of the Bill by the F.B.I. I would like to ask him, as both a member of that body and a Member of Parliament, how he will propose to obviate what is no doubt a very influential and forceful opposition when the Bill is passing through the House?

Mr. Nabarro: I am grateful to you, Sir, for seeking to negative what I consider to be routes of escape from the principle that all of us espouse and have at heart. Everybody in the British nation today believes that clean air is a jolly good thing. A very large percentage of the British nation have not got a clue as to how it may be achieved, and a lot of them, once they hear the details of how it is going to be achieved, are in opposition to it. I have pinpointed this morning the seven year *in extremis* provision for dark and black smoke. By seeking to reduce that to three years, I am negativing what has been sponsored from certain quarters and by certain bodies. That is my Parliamentary prerogative and function, and I am sure Mr. Robens will be with me.

Mr. Winchester, St. Pancras: We have heard that you cannot stop puffers puffing. I come from a borough in which we have three main line stations. Associated with each station is a motive power depot. At these depots anything up to 100 *express locomotives are serviced daily. At any one time there are* 40 *locomotives in steam or, in fact, under smoke. It is all very well to think of railway smoke as an isolated engine at the end of a platform tranquilly emitting smoke. It is also very well to think of smoke emanating from perhaps one or two engines in goods yards. So far as St. Pancras is concerned, when there are* 40 *steam express locomotives, each one emitting only a little smoke, adjacent to residential property, then there is a problem comparable to any industrial installation similarly emitting smoke. So far as St. Pancras is concerned, we shall not be satisfied unless there is legislation to stop the ordinary puffer puffing even one puff of smoke.*

Mr. Nabarro: I come well qualified and equipped to answer Mr. Winchester from St. Pancras because I have followed with the greatest interest the activities of the Chalk Farm Residents' Association in their action against the British Transport Commission which arises from the smoke nuisance at the Camden Locomotive Depot on the London Midland Region. The Chalk Farm Residents' Association among other things have said: " Why not eliminate this smoke by requiring that a large duct be fitted to the locomotive shed, so that all the smoke from the railway engines may be channelled up this one duct, carried to a great height and thereby dispersed? " That, of course, neglects, as I see it, the fact that most of the nuisance does not arise from locomotives in the shed. Most of the nuisance arises from the locomotives in the yard adjoining the shed, and they are locomotives that have come off express trains or are about to be coupled to express trains; and I see little chance of really effective legislation to prevent such railway engine smoke. It is an administrative act. The modernization and re-equipment programme of British Railways, to be

implemented over twenty years at a cost—at today's prices—of about £1,200 million, envisages widespread electrification and dieselization of traction and equipment. That is the answer.

It is, in my view, impracticable and unrealistic to repeat what the Railway Acts of 1845 and 1868 said, which was that the owner of a railway engine would be culpable if he allowed it to produce any smoke. The position is very largely the same today, and while by this Bill we try to minimize the nuisance by repeating that it is an offence, the real answer is long-term and administrative, namely, the electrification and dieselization of the railways, with the additional electricity supplied, I sincerely hope, by atomic power.

Mr. W. Bate, Wallasey: The point I wish to raise and the question I wish to put to the panel is what Mr. Robens will probably describe as a Committee point. It is a very important one and is concerned with Clause 9, on the repayment of contributions by the local authority in respect of adaptation of fireplaces. I would like to know whether the speakers think that the following construction of the clause is correct and whether it was intended; and if so, will they seek to alter it? Clause 9 authorizes a local authority to make these contributions where the alterations have been carried out. The words are: "after the confirmation of the order, but before the order comes into operation." The section also authorizes a local authority to serve notices to require the adaptation. Now let us assume that the local authority finds itself bound to serve a notice to require adaptation. If the person concerned complies with it within this period, after the order has been confirmed, but before the order comes into operation, all well and good: he gets his allowance. Let us suppose that he does not comply with the notice until after the order has come into operation. He does not get his contribution. Let us suppose then that the local authority takes action in default. What happens then? The local authority, according to my construction, is only entitled to recover three-tenths of the cost. Is that a correct construction, and if so, is it not completely screwy?

Mr. Robens: Our friend was perfectly correct when he said it was a Committee point, because I have heard speeches like that hundreds of times in the House of Commons in Committee. They do not usually end by asking "Is it screwy?" But the purport is there just the same. Now there will be a very large number of these points. It is the sort of thing that is argued in Committee, and there is no doubt everyone here can read this Bill and they can say "now, how do you construe clause so and so?" In this event what happens, and in another event, what happens there? Hypothetical cases are raised, and one could have an entertaining day discussing these things, but I would suggest that the local authority associations ought to have all these local authority points put to them so that they can be examined. They may come to the conclusion, with all their expert knowledge, that a clause is not clear and it ought to be made clear, or that the purpose of the clause will not be served by the words that are used in the clause—and they have very excellent officers who are able to draw briefs with arguments based upon experience. The Committee that will be dealing with this Bill, I can assure you, will be a very objective Committee. It will not be arguing out politics, and I am sure that the Government speakers will not be insisting that their particular clauses must be carried, because it is a matter of Government business, but they will look at it objectively. Therefore, I would urge every single delegate here who has views, particularly officials of local authorities, to use the local authority associations as a channel for bringing all these odd points in so that they can prepare, well in advance, the sort of questions and arguments that ought to be used in Committee. I am quite sure that this is very good advice.

Otherwise you would find that you could take this Bill and you could go on arguing for days about it, and you might just be duplicating one another. Therefore, I do urge you to use your local authorities for raising these small points, so that they can examine them, and when the Committee stage is reached all these points can be thoroughly discussed.

Mr. A. Ludgater, Solid Smokeless Fuels Federation: Would not the most economical, viewed in its widest sense, nationally and generally, means of increasing availability of solid smokeless fuels be the increase in production by straight carbonization methods of coal as in existing practices in gas works and coke ovens?

Mr. Nabarro: That is, of course, true, theoretically, and there is the practical consideration that vast and complex plants would be required to increase the carbonization facilities. My personal view is that the appendix published in the Beaver Report by Dr. Foxwell is the most illuminating and informative short treatise on this very difficult problem. No doubt there will be an increase in carbonization facilities. As I said earlier this morning, I want to see an increase as well, in the smokeless solid fuel production facilities both of the Coal Board and of private firms. I think an aggregation of those three factors ought to provide sufficient smokeless fuels for the expansion of smokeless zones provided there is proper Ministerial control, as surely there will be, over the rate of the expansion of those zones.

Mr. C. H. Crawford, Brierley Hill: Mr. President, I was quite prepared for my question to be read from the table, but I am concerned that in the removal of powers from the local authorities there has been a suggestion that certain authorities should be allowed to retain the special processes. In my view, it is no use allowing those local authorities or any local authorities to retain those powers unless you give them the same control over these special processes that the Alkali Inspectorate has. We know that in other industries, control went over to Ministries. It was said that the local authorities did not do the job. But the Ministry, when it took it over, was given additional powers with which they were able to use a bit more force, and I wonder whether you can help on this particular point?

Mr. Nabarro: With respect, you have said almost exactly what I said an hour ago, almost exactly. The plain fact of the matter is that the majority opinion, I believe, among the local authorities and informed circles elsewhere, is that autonomy for the special processes should be retained by the big authorities, and that they should be able to go for advice to the Alkali Inspectorate if they wanted, but the Alkali Inspectorate should continue to administer in the case of the smaller authorities. You come from Brierley Hill; that is the authority next door to Kidderminster, which I sit for, so I know Brierley Hill very well. Without being at all derogatory about Brierley Hill, it has not available the facilities, as a local authority, in regard to these special processes, such as the City of Manchester, or the City of Liverpool, or the City of Sheffield could have, and there must be that distinction between such authorities. Other than that, the powers of the Alkali Inspectorate are adequate so far as practical means of reduction of emission of fumes are known, but there are very many such processes, as my friend Dr. Parker, seated in the audience, will be the first to agree. In the case of many of these processes, there is no practicable means known of preventing the emission of the fumes unless the plant were shut down altogether. Such a course would be unthinkable as many of these plants are vital to our National Economy.

Cllr. T. E. Morgan: I am a miner. I come from a mining area, and I represent a local authority which is ringed by collieries. A short distance away from

there we have quite a lot of industrial plants in Doncaster, which is only two and a half miles away. While the N.C.B. have gone to enormous expense to put in modern ways of feeding the boilers, we still get a terrific amount of smoke and sulphur smells from what they tip on the refuse tips, which are an awful sight around most collieries. I would like to know from the panel if they feel that some form could be put into the Bill whereby anyone who has a tip of such a kind must at least reduce the smells and fumes and smoke which come from them?

Mr. Nabarro: I am grateful to you. You are one of the most important men in the Conference because you are a miner. The Bill says this on Colliery Spoilbanks: " Subject to the provisions of subsection 3 of this section, the owner of a mine or quarry from which coal or shale has been, is being or is to be got, shall employ all practicable means for preventing combustion of refuse deposited from the mine or quarry and/or preventing or minimizing the emission of smoke and fumes from the refuse, and if he fails so to do he shall be guilty of an offence." Thus only the National Coal Board can find the answer to this! But there it is, in black and white, and it is going to be a difficult thing to deal with colliery spoilbanks all over the mining areas. Mr. Robens sits for a mining constituency, and he knows the problem better than I do. I have not a single coal mine left in my constituency.

The Chairman, Sir Ernest Smith: I think we have had a most marvellous, constructive, and useful discussion. I think we are very much indebted to two experts to come and give us first-hand replies and advice on all these matters. The questions that have been put have been intelligent and useful, and we have, all of us, got a very much clearer idea of what the problems are of getting this Bill through. I have the very greatest pleasure in thanking Mr. Alfred Robens and Mr. Nabarro for coming here today at considerable inconvenience and giving us the very best advice they can, and would be glad if you would show your appreciation. (*Applause*)

Mr. Nabarro: This session would not be complete without my voicing, on behalf of Mr. Alfred Robens and myself, our appreciation to your President, Sir Ernest Smith, for the admirable way in which he has conducted the affairs of this tumultuous meeting this morning. Mr. Robens and myself—I know I speak for both of us—are delighted to have come here and to have been able to speak to a body which has been at the spearhead of the attack upon atmospheric smoke pollution for many years. And please believe this, Ladies and Gentlemen, as a final word through your President, the passing of this Bill and its reaching the Statute Book in the early months of next year will not in any way diminish the importance of the work of this Society.

Recent Progress in Domestic Heating by Centralized Methods

THE WESTMINSTER CITY COUNCIL'S DISTRICT HEATING SCHEME—I

by

Alderman C. P. Russell, C.V.O., J.P.

1. Genesis of the Churchill Gardens Housing Estate and the District Heating Scheme

(a) Post-War Housing

While London was still healing the wounds inflicted during the blitz of 1940-41, the Westminster City Council was already making plans to carry out a programme of post-war housing. By October 1943 the Council had decided upon the site and extent of its major housing scheme.

The site selected was one of 33 acres fronting Grosvenor Road and the River Thames and bounded on the north by Lupus Street, 150 yards east of the Grosvenor Road railway bridge over the Thames.

Many of the buildings on this site had been completely destroyed; others were severely damaged; and the remainder were for the most part obsolescent or nearing the end of their useful life and the whole area called for development.

In Westminster land is very expensive and the only economic form of development for housing must include a preponderance of tall blocks of flats. A public architectural competition was held in 1945-46 and the winning designs were submitted by Messrs. Powell and Moya. Their scheme provided for the erection of a series of blocks of seven and nine stories, with smaller blocks and terrace houses and maisonettes, sufficient to accommodate 1,650 families.

The scheme is of necessity being carried out in four sections, and work was commenced on the first section in 1948, Section II in 1953, and on Section III in 1955. Section IV should commence in January, 1957.

(b) Space heating and domestic hot water

The conditions of the Architectural Competition required central heating and a constant supply of hot tap water to be provided for each flat and prohibited the provision of open fireplaces.

Originally the Council had in mind the construction of two boiler houses, each to meet the requirements of about one-half of the new housing estate; in other words the provision of central heating and hot water on traditional

lines. But in 1946 it addressed itself very seriously to the question whether the bolder concept of district heating from an existing source of heat could be realized.

On the other side of the river and within half a mile of Churchill Gardens was Battersea Power Station with an abundance of exhaust steam. Sir Leonard Pearce, the Engineer-in-Chief of the London Power Company, was sympathetic to tentative enquiries. Under the river was a tunnel carrying the Metropolitan Water Board's mains and capable of accommodating conduits carrying hot water from the Power Station to the fringe of the new estate. Next door, at Dolphin Square, there was a potential customer whose patronage could overcome a major teething trouble—the scarcity of consumers during the early stages of development when only a few blocks of flats in Churchill Gardens would be occupied.

The omens appearing propitious, the Council invited the late Mr. S. B. Donkin of Messrs. Kennedy & Donkin to examine the problem and submit a comprehensive report.

(*c*) *Mr. Donkin's Report*

Mr. Donkin's Report was considered by the Council in October, 1946. It was a formidable document containing an exhaustive examination of three alternative methods of providing district heating to the Churchill Gardens Estate (a central boiler house, a heat electric station, a heat pump) as well as the possibility of bringing heat from Battersea Power Station.

The Report drew attention to:

(*a*) the principal advantages of district heating—prevention of atmospheric pollution, saving of fuel and economy of labour; and

(*b*) the conditions at Churchill Gardens which were favourable to the installation of district heating—a dense population (200 persons to the acre, 55-60 flats per acre) having a common landlord, estate roads under which conduits would be placed, the proximity of the Power Station and the presence of tunnels under the Thames.

Estimates of cost prepared by Mr. Donkin (based on prices then prevailing) showed that heat purchased from Battersea Power Station could be economically sold to the consumer at a price of approximately 5½d. per therm as against slightly more than 6d. if a central boilerhouse were installed; that the average weekly charge to a tenant would be about 4s. 9d. per week; and that if conventional methods were adopted a tenant would have to pay about 7s. 9d. per week for half the amount of heat which would be supplied by district heating.

2. Westminster City Council's decision to adopt District Heating

On the strength of Mr. Donkin's Report the City Council decided that on financial grounds and in view of the overwhelming environmental and other advantages it should adopt the system of obtaining heat from the Battersea Power Station.

Statutory powers were necessary, because, although the Council could lawfully supply the tenants of its housing estates with space heating and hot water it had no power (1) to break open streets for the laying of conduits, or (2) to sell heat to the occupiers of premises outside the housing estates who could use the scheme to advantage.

The Council's application to Parliament evoked opposition from existing suppliers of heat and comments from Government Departments. In consequence the powers granted to the Council to establish its district heating undertaking were conditioned by requirements for, *inter alia:*

(1) the Council's proposals (including the standard of heat to be supplied) to be submitted to the Minister of Fuel and Power for approval, and for gas, water and electricity undertakings operating in the area of supply to make representations to the

Minister to secure the protection of their mains;

(2) the heating charges made by the Council to be so fixed that as far as is reasonably practical the income from the undertaking is not less than the expenditure on the undertaking;

(3) the Council to keep a separate account of the undertaking;

(4) the Council to give any electricity and gas undertakers such information about the working of the undertaking as they may reasonably require;

3. The Scheme in Operation

(a) Growth of the Undertaking

Space heating and hot water was first supplied to 104 flats in Churchill Gardens on February 20th, 1951.

On September 25th, 1951, the undertaking was connected with Dolphin Square to supply space heating and hot water to 1,200 flats and the guest rooms, restaurant, shops, offices, swimming pool and garage which were formerly supplied by the boilers in Dolphin Square.

By September 17th, 1952, the undertaking was connected to a block of 74 flats in Russell House, which had previously been provided with space heating and hot water by boilers.

Today the undertaking supplies heat and hot water to the following premises:

1,054 flats and other dwellings occupied by tenants of the Council. These tenants must pay the weekly charges fixed by the Council (see post).

1,200 flats in Dolphin Square by arrangement with the landlords who purchase heat from the Council under a contract providing for the payment of an annual sum and a charge for each therm as measured by meter.

A further 837 flats, etc. in Churchill Gardens and Abbots Manor will eventually be connected.

The foregoing represents the extent of the scheme at present in the contemplation of the City Council. Whether the Council will eventually decide to extend it further remains an open question for the time being. In theory and in law the Council can extend the scheme to any premises within the City's boundaries but there is not only a limit to the amount of heat which can be economically purchased from Battersea Power Station, but a point at which the expense of laying extensions to conduits is not justified by the revenue from the extension of the undertaking.

(b) Finance of the Scheme

The late Mr. Donkin's estimates of cost were based on the only materials available to him—current prices in 1946 and probable increases. The sharp but sustained rise in the cost of labour and materials and fuel which have since taken place were neither foreseen nor foreseeable.

(c) Cost

To date the costs incurred by the Council in providing the heating undertaking are as follows:

Capital expenditure (e.g. mains, structure of pump house) up to 31.3.55 ..	£250,000
Capital charges per annum, 1954-55	£11,800
Working costs per annum, 1954-55	£42,300
Total capital charges and working costs per annum, 1954-55	£54,100
Total cost in pence per therm of heat purchased from Battersea Power Station	9.33d.

(d) Charges to Occupiers

For the purpose of charges the occupiers are divisible into two broad categories:

(1) *Tenants of Council's Residential Accommodation*

These are the occupiers whom the scheme was primarily intended to serve. The conditions of their tenancy require them to pay the heating charge prescribed from time to time by the

Council. They do not escape liability to pay the charge if they refrain from using the hot tap water or the radiators —the Council could not possibly embark on an undertaking of this magnitude if it were a matter of discretion for each individual occupier to pay the Council for district heating or to escape payment by purchasing heat for space heating and hot water from other sources.

The problem of fixing appropriate charges arose when the first blocks of flats in Churchill Gardens was connected to the undertaking at the end of 1950. The Council recognized that in the early days when few flats were occupied it would be involved in a loss; but that this loss would decrease progressively as more and more flats were occupied and might well be expected to be converted into a profit. It therefore made no attempt in 1950 to impose a charge which would secure recoupment of the annual capital and working costs payable at that time. Instead it was content to make the following interim scale of charges:

Size of flat	*Charge per week* *s.*	*d.*
Bed-sitting room	3	7
Two room	6	7
Three room	8	0
Four room	9	5
Five room	10	9

By 1952 it had become apparent that in view of increases in the cost of labour, materials and fuel since 1950, delays in the construction of new flats, rises in interest rates and the demand for space heating to be maintained until 11.30 p.m. instead of 10 p.m., it would be necessary substantially to increase the then current charges to enable future income to meet the outgoings and to pay off the accumulated deficit within 20 years. The Council therefore prescribed a new scale which increased the weekly charges by about 18 per cent.

By July 1954 not only had further increases been made in the cost of fuel at Battersea Power Station, but experience had shown that a great deal more heat was being consumed than had been expected. It was therefore necessary to increase the charges fixed in 1952 by approximately 12½ per cent.

The charges for heating and hot water at present in force are:

Bed-sitting room ..	4s. 10d.
Two-room flat ..	8s. 9d.
Three-room flat ..	10s. 7d.
Four-room flat ..	12s. 6d.
Five-room flat ..	14s. 2d.

The annual income from the 1,030 flats of the Council's estates in 1954-55 was £29,000.

(2) *Dolphin Square and the occupiers of premises other than residential accommodation belonging to the Council.*

The charges paid by these occupiers are agreed *ad hoc* having regard to the estimated amount of heat made available to them, except in the case of Dolphin Square where the actual amount supplied is measured by meter and paid for.

The annual income from this class of occupier at present amounts to £24,300.

(*e*) *Summary of Finance*

(i) During the year ended March 31st, 1955—
- (*a*) the cost falling on the Council was £54,100
- (*b*) the charges recovered from occupiers were £45,100

(ii) When the scheme is complete it is estimated that—
the total capital expenditure will be £300,000
the annual capital charges will be £16,300
the annual working costs will be £57,000.

On this estimate the heating charges at present in force would enable the undertaking when complete to be financially self-supporting.

(*f*) *Operating Experience*

When dealing with very large numbers of flats with differing aspects and differing constructions, e.g. brick

load bearing walls, monolithic reinforced concrete construction, blocks ranging from three to eleven storeys, maisonettes, etc., the technical problems involved in ensuring that each dwelling is heated to the same standard become very complicated and inextricably mixed with the architectural side of the problem.

It became evident some time after the Undertaking commenced to operate that one of the main problems would be to educate the new tenants in the ways of extracting the maximum benefit and comfort from the new heating medium. The great majority of the tenants had only had experience in traditional methods of heating with the coal fire as the focal point of warmth and comfort, and so an illustrated pamphlet was issued to all tenants setting out a series of Do's and Dont's concerned with the judicious use of doors and windows and the slow building up of warmth in a room after the windows have been left open. It was also necessary to point out that although hot water was available in plenty, the extravagant use of hot water was in fact wasting heat and this eventually would become an increased charge on their pockets.

(g) Operating Conditions

The system is designed to keep living-rooms at 65°F. and bedrooms at 60°F. and 55°F. (according to the estate), with an outside temperature of 30°F. In practice, living-room temperatures are on the average nearer to 70°F., especially in the evenings. It is remarkable that although the heating is shut down during the night hours, the temperature drop is only of the order of 2°–3°F.

The hot water supply is by bulk calorifiers in the basements of the large blocks which in some cases serve small blocks as satellites. The supply is kept at about 130°–135°F. and the estimated demand is 15 gallons per head per day.

The heating season extends nominally from October 1st to April 30th, but the Council retains discretion either to lengthen or shorten the season at either end, according to the weather conditions at the time. This, of course, works to the tenants' advantage. Each day, in the season, the heating pumps are started at 6 a.m. and closed down at 11.30 p.m., except at the beginning and end of the season when appreciable economies can be effected during spells of hot weather in April and October.

(h) The advantages of the scheme

As has been related in this paper, the area ripe for development in Westminster possessed all that is required and therefore the advantages of having such a system can be enumerated as—

(*a*) the provision of an ample, cheap and convenient form of heat for space heating and for hot tap water in an urban area.

(*b*) The prevention of atmospheric pollution.

(*c*) A considerable saving in the amount of coal used per annum per head of population.

(*d*) A saving in labour and increased cleanliness, especially in domestic premises, both interior and exterior.

(*e*) A consequent improvement in the standard of living conditions.

By 1960, when the original demands have been met, there will be some 11,000 people living in the 3,200 or so dwellings and it is estimated that about 11,000 tons of coal per annum will be saved, as compared with providing the same standard of space heating and hot water by normal central heating boilers at Dolphin Square and Russell House (1,294 flats) and traditional methods of heating (coal, gas, etc.) to the remainder providing only a much lower standard of amenity.

All this without the emission of any smoke or fumes of any kind other than that produced at the Power Station which would be produced in any case. In fact a truly smokeless zone.

(i) Possible disadvantages

1. Of course like all highly centralized schemes one inevitably has to

consider the possibility of a breakdown and its results.

Fortunately if there were a breakdown of apparatus at Battersea Power Station an alternative source of heat could quite quickly be provided.

The other possibility of a fracture of the mains is not thought to be material and if it did occur it could be repaired in a short time.

Each flat is provided with power points for electric heating and most tenants cook by gas so that not much discomfort would follow for the short period required to make repairs. Electric power points are installed to enable the tenants to supplement their central heating under extreme conditions of cold or for those tenants who wish for a higher temperature than is provided.

It would not have been economically practical for the scheme to have been designed to meet these extremes entailing as it would larger mains, greater storage capacity and larger radiators in the flats. All of this extra provision would have been unnecessary except for a few days in a heating season.

2. The only other possible disadvantage is that tenants are required to pay the same weekly charge all the year round, irrespective of their use of the service or their ability or willingness to buy the comfort provided. This comfort, it must be admitted, is greater than the majority of them might consistently provide for themselves. In hard times they would no doubt economise to a certain extent in purchase of fuel and the use of hot water.

But experience has shown that once having experienced the luxury of the service, tenants appear to be quite content and there is a keen demand for accommodation in Churchill Gardens.

(j) Conclusions

After five years' experience the scheme has proved to be a complete success and a much appreciated amenity by the tenants. At the same time it is only right to point out that the conditions in Westminster were peculiarly favourable. The presence so near of Battersea Power Station, the existing tunnel under the river and the existence of Dolphin Square with 1,200 flats and other services to be supplied with heat at the inception of the scheme were factors which have had a material effect on its successful development.

THE WESTMINSTER CITY COUNCIL'S DISTRICT HEATING SCHEME

II—THE ENGINEERING ASPECTS

by

Bryan Donkin, B.A., A.M.Inst.C.E., M.I.E.E.

The supply of heat for the Pimlico District Heating Undertaking is purchased by the Westminster City Council from the Central Electricity Authority at Battersea Power Station where it is metered. The heat is delivered to the Pimlico Estates in the form of hot water passing under the River Thames through pipes laid in a tunnel belonging to the Metropolitan Water Board. The general layout of the Scheme is shown on the attached figure. On the left side of the figure, Battersea Power Station is shown and in the lower right-hand corner two back pressure turbo-generators with heat exchangers and circulating water pumps are indicated. The heating water is transmitted through heating mains in the tunnel to the sub-station at Churchill Gardens of which a typical block of flats is shown on the right. The heating water is circulated from the sub-station by an independent set of pumps to the radiators and calorifiers in the flats in Churchill Gardens, Dolphin Square, and the recently completed extension at Abbots Manor.

The water which circulates under the river is heated by the exhaust steam leaving the back pressure turbines which is condensed in the heat exchangers or calorifiers through which the heating water circulates. It is a most important feature of the Scheme that no provision is made for discarding heat to the river as in the case of conventional condensing turbines.

As in all other schemes using combined heat electric generation, provision has to be made for the demand for electricity not synchronizing with the demand for heat. In previous schemes this difficulty has been surmounted by the use of conventional condensing plant which dissipates any heat leaving the turbines in excess of that required for heating purposes.

In the case of the Pimlico Scheme the back pressure turbines are operated during the winter months to supply electricity as and when it is required at Battersea Power Station and excess heat is stored in the heat accumulator shown on the attached figure. The accumulator also serves to supply heat to the blocks of flats in the event of the exhaust steam from the back pressure turbines being less than required. If as is often the case the back pressure turbines are stopped, water is circulated through the radiators and calorifiers in the flats by the pumps at the sub-station, hot water being taken from the top of the accumulator and the cooled water pumped back to the bottom. Alternatively, if circulation to the flats is stopped while the back pressure turbines are running the hot circulating water is delivered to the top of the accumulator and the cooler water is drawn off from the bottom. In the event of the pumps at Battersea and at the sub-station running together, the accumulator balances out the difference in heat supply and demand, all of which happens automatically as in the case of an electricity accumulator connected across the bus-

A General View of the

The Heat Accumulator

bars of a direct current power station. By this means the combined maximum heat output of the two back pressure turbo-generators of 455 therms per hour, is sufficient to meet the peak demand of 750 therms per hour. This is achieved by running the sets continuously on cold days if necessary for twenty-four hours, and by making use of the accumulator to store the excess heat output in the off-peak times of demand for heat and to make up the deficiency of heat output during the times of maximum demand for heat.

Reducing valves and desuperheaters are installed to supply low pressure saturated steam to the heat exchangers at Battersea from the 600 lb./sq. in. steam mains in the unlikely event of the failure of the back pressure turbines.

The chief technical particulars of the combined heat electric generating plant at Battersea Power Station are as follows:

Two machines, each of maximum continuous output ..	1,350 kW
Exhaust heat, per machine ..	227.5 therms/hr.
Voltage of electric output	3,300 volts
Temperature of heat output	200°F.
Initial steam pressure.	600 lb./sq. in. gauge
Initial steam temperature ..	800°F.
Back pressure of exhaust steam.	2 lb./sq. in. gauge
Turbine speed ..	10,000 r.p.m.
Alternator speed ..	1,500 r.p.m.

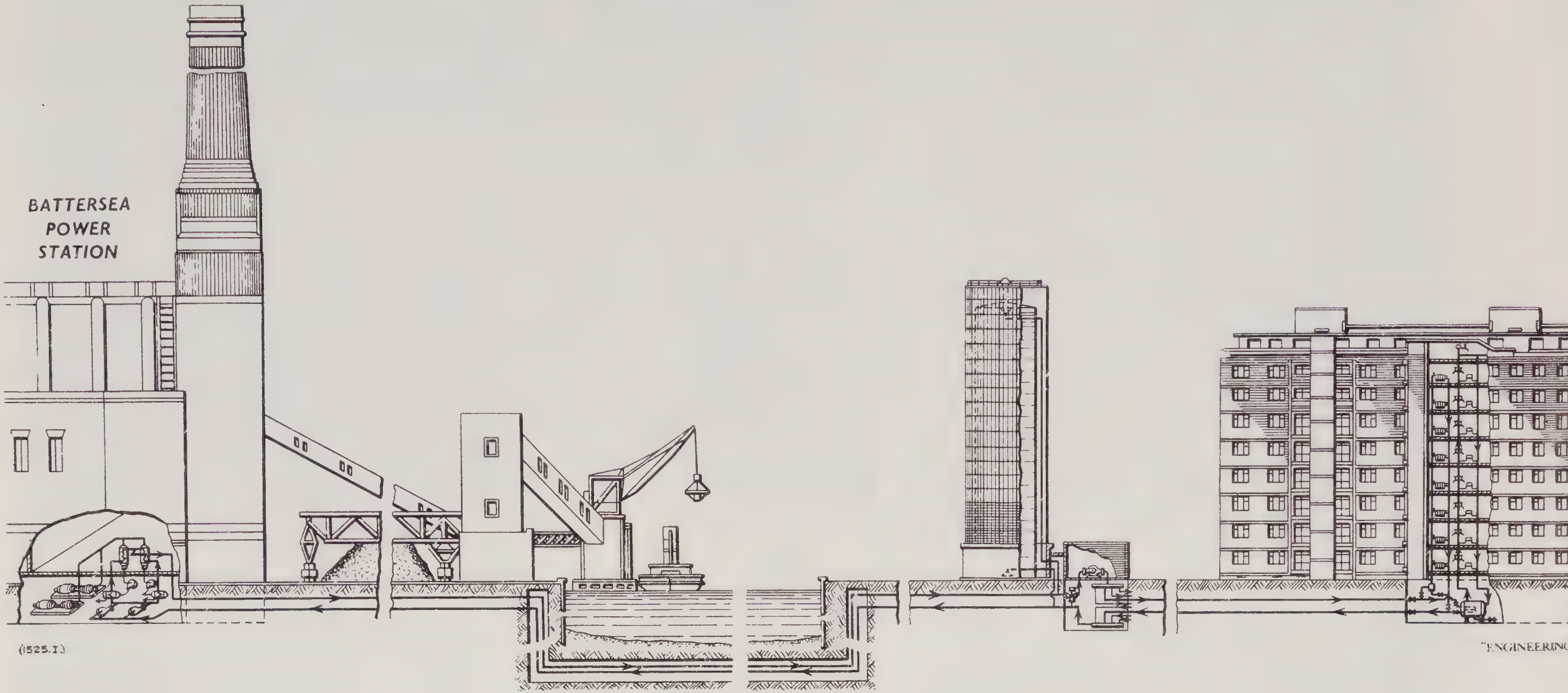


Diagram of the Pimlico District Heating Scheme

The transmission mains are provided with bellows type expansion pieces except in the tunnel where the profile of each 12 in. main forms in itself a large expansion point with an anchorage in the middle of the under river tunnel. The heat insulation of the pipes consists of cork sectional coverings 2 ins. thick.

The accumulator consists of a vertical cylindrical vessel of steel construction with the following dimensions:

Inside diameter ..	29 ft.
Height	126 ft.
Volume	80,000 cu. ft.
Effective heat storage for 80°F. rise	4,000 therms
Heat storage per cu. ft.	5,000 B.T.U.

It might be noted that the heat content of each cu. ft. of water stored is ten times that of a cu. ft. of town gas with a calorific value of 500 B.T.U./cu. ft.

The accumulator is enclosed in a steel-framed glass structure which is 138 ft. high, and is in the form of a 16-sided polygon in plan. The main purpose of the enclosure is to enhance the appearance and to conform with the general architectural scheme of the housing estate, a view of which from the South Bank of the Thames is shown on the attached photograph.

It is now four years since the Pimlico District Heating Scheme was opened and it has been in successful operation without any interruption since then. Operating records are available throughout the period of operation of the station and consistent results have been obtained showing that the designed quantities of heat and electricity have been delivered for use in the blocks of flats with an overall thermal efficiency of 82 per cent. for generation and 95 per cent. for transmission and distribution.

It is an important point in the economy of the scheme that the whole of the electricity produced, amounting to 5 kWh per therm supplied, is purchased by the Central Electricity Authority and the revenue obtained forms a reduction of the total cost to the heat consumers.

The Pimlico combined heat electric scheme has been designed as a prototype scheme to demonstrate that a reliable supply of heat can be given by heat electric generation. The main requirement was security of supply and to meet this condition some reduction in thermal efficiency had to be made by adopting the simplest possible design. Experience in the operation of Pimlico has made it clear that in any future schemes a higher ratio of electricity to heat output can safely be attained.

The total saving in coal which will result under the ultimate Pimlico Scheme is estimated to exceed 3,000 tons per annum and the heat output is estimated at about two million therms per annum. If account is taken of the elimination of open fires and other thermally inefficient methods of heating the total saving in coal achieved by the Pimlico District Heating Undertaking will it is estimated exceed 10,000 tons per annum for the same quantity of heat supplied.

ELECTRICAL FLOOR WARMING

by

J. W. Moule, B.Sc. (Eng.), M.I.E.E.

Introduction

Electrical floor warming is a comparatively new method of building heating, although floor warming in itself goes back a very long time. The early Koreans used it for heating their dwellings and it is well known that the Romans went to considerable trouble in building a system of ducts below their houses to enable the floors to be warmed from underneath. Their usual plan was to provide a heating chamber on the outer wall of the house, so arranged that the hot gases from a fire were drawn into the passages under the floors and escaped to the atmosphere through flues built in the walls of the building.

Nothing much was done about developing this principle of heating until about 40 or 50 years ago when hot water heating in floors was introduced. This took the form of copper piping embedded in concrete floors. Hot water circulating in the pipes raised the temperature of the floor with the result that it became a large low temperature heat radiating area. The hot water system with its controls was rather complicated and somewhat expensive to install. In consequence it has not been greatly used in this country, although it is more popular in America.

During the last few years considerable interest has been aroused in electrical floor warming, in which the hot water pipes are replaced by electrical heating cables. The fundamental idea is that, whilst the building is under construction, small semi-circular metal ducts are embedded in the concrete floors, the ducts terminating in troughs with removable covers. Electrical heating cables are later drawn into the ducts, or they can be directly embedded in the floor in which event the ducts are unnecessary. Electrical floor heating is much less costly to install than the hot water system, as the elaboration and expense of hot water pipes, boiler, boiler-house, chimney, etc., are saved.

Electrical floor heating is in successful use in a large number of buildings, particularly in Scotland. The first blocks of houses to be heated in this manner were 3 three-storey blocks of flats at Inverness. The most recent example is an eight-storey high block of flats at Kirkcaldy, although a ten-storey block of electrically floor heated flats is now under construction in Glasgow.

The Kirkcaldy Flats

The Kirkcaldy flats (Figure 1) are built to a " T " shape design with three wings grouped around a central tower which accommodates lifts and staircases. Each wing has a two apartment and a three apartment house on each floor, and the building contains a total of 48 flats.

Figure 2 shows a cross section of an intermediate floor. It will be noted that the floor consists of hollow concrete Bison floor slabs covered with paper-bound glass insulation. The electrical floor warming system is laid out on top of the glass in the manner shown in Figure 3. Semi-circular aluminium ducts (flat side uppermost) are placed in parallel lines across the glass insulation and terminate at the far end of the room in the space which later, will be the cable trough. The trough will enable the heating wires to be installed and will also accommodate the electricity supply cables. Expanded metal is placed on the aluminium ducts and clamped to them.

Fig. 1

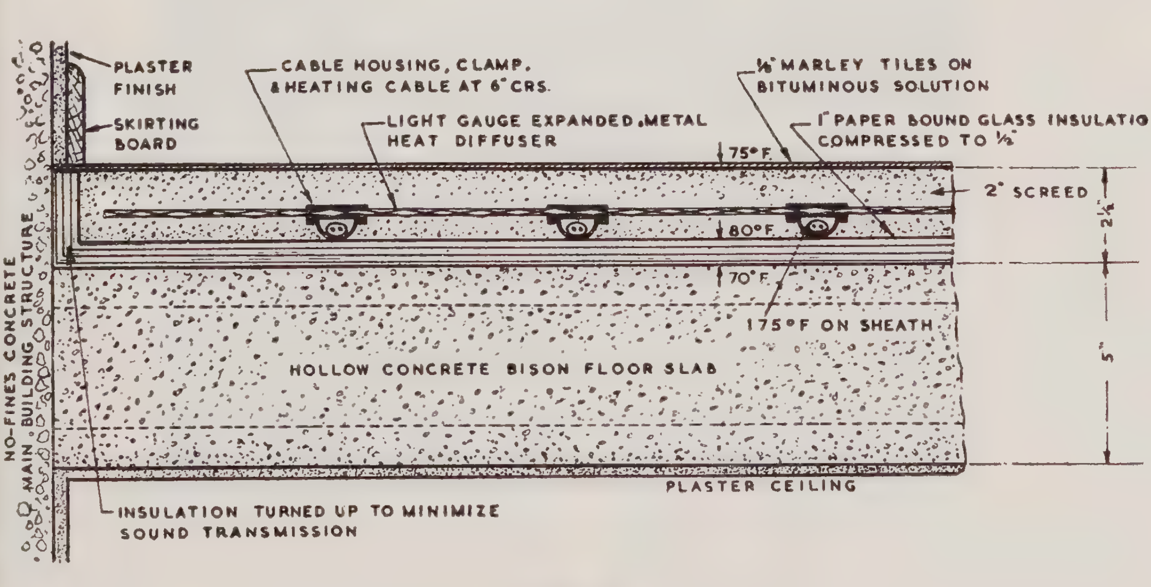

PLASTER FINISH
SKIRTING BOARD
CABLE HOUSING, CLAMP. & HEATING CABLE AT 6" CRS.
LIGHT GAUGE EXPANDED METAL HEAT DIFFUSER
1/8" MARLEY TILES ON BITUMINOUS SOLUTION
1" PAPER BOUND GLASS INSULATION COMPRESSED TO 1/2"
75°F.
2" SCREED
2 1/2"
80°F.
70°F.
175°F ON SHEATH
HOLLOW CONCRETE BISON FLOOR SLAB
5"
NO-FINES CONCRETE MAIN BUILDING STRUCTURE
PLASTER CEILING
INSULATION TURNED UP TO MINIMIZE SOUND TRANSMISSION

Fig. 2

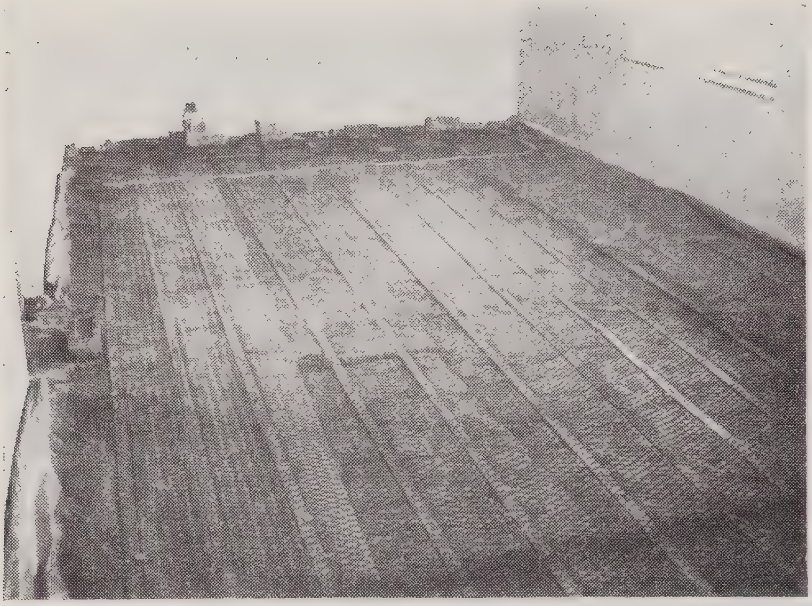


Fig. 3

Finally a top 2 in. screed is laid, care being taken to work the screed through the expanded metal. When the building work is finished, the heating cables are drawn into the aluminium ducts and connected to the electricity supply cables by suitably placed terminal boxes.

Figure 4 is a close-up photograph looking downwards on a trough. The aluminium ducts can be seen emerging from the screed and entering the trough at the bottom. The heating cables, after leaving the ducts, are " snaked " along the bottom of the trough to the terminal boxes, which also receive the steel conduit carrying the electricity supply cables. The trough has a cover which fits flush with the top of the floor.

The heating cables comprise two cupro-nickel resistance conductors insulated by asbestos and enclosed in a lead sheath. The conductors are joined at the far end of the cable which is therefore a self-contained heating device. As the cables operate at a temperature of only some 180°F., there is no question of deterioration with service, and they should last indefinitely. If, however, a fault should develop in a heating cable, the cable can be readily replaced at low cost.

After installation the heating system is completely out of sight, the only visible part being the thermostat provided in the living-room. This control enables the warmth to be maintained at any desired level.

It was not considered necessary to install floor heating in the bedrooms and kitchens. The bedrooms will probably obtain sufficient warmth from the heat transmitted through the building, but electric power points are provided in every room to permit the use of electric radiators. The Kirkcaldy Corporation have installed a 2 kw electric radiator in each living room, and this serves to provide a focal point in the room as well as any additional warmth which may be required during extremely cold weather.

Off Peak Use of Electricity

An outstanding feature of electrical floor warming, when installed in concrete floors, is that the use of electricity can be confined to the electricity " off peak " periods. This generally permits the application of an advantageous " off peak " tariff which in the case of the Kirkcaldy flats is 0.7d. per unit. Electricity supplies are available during the night-time and for a few hours in the middle of the day. During these periods the concrete floors are heated up to the required value (determined by the setting of the thermostat) and the immense amount of heat stored in the floor is sufficient to maintain the

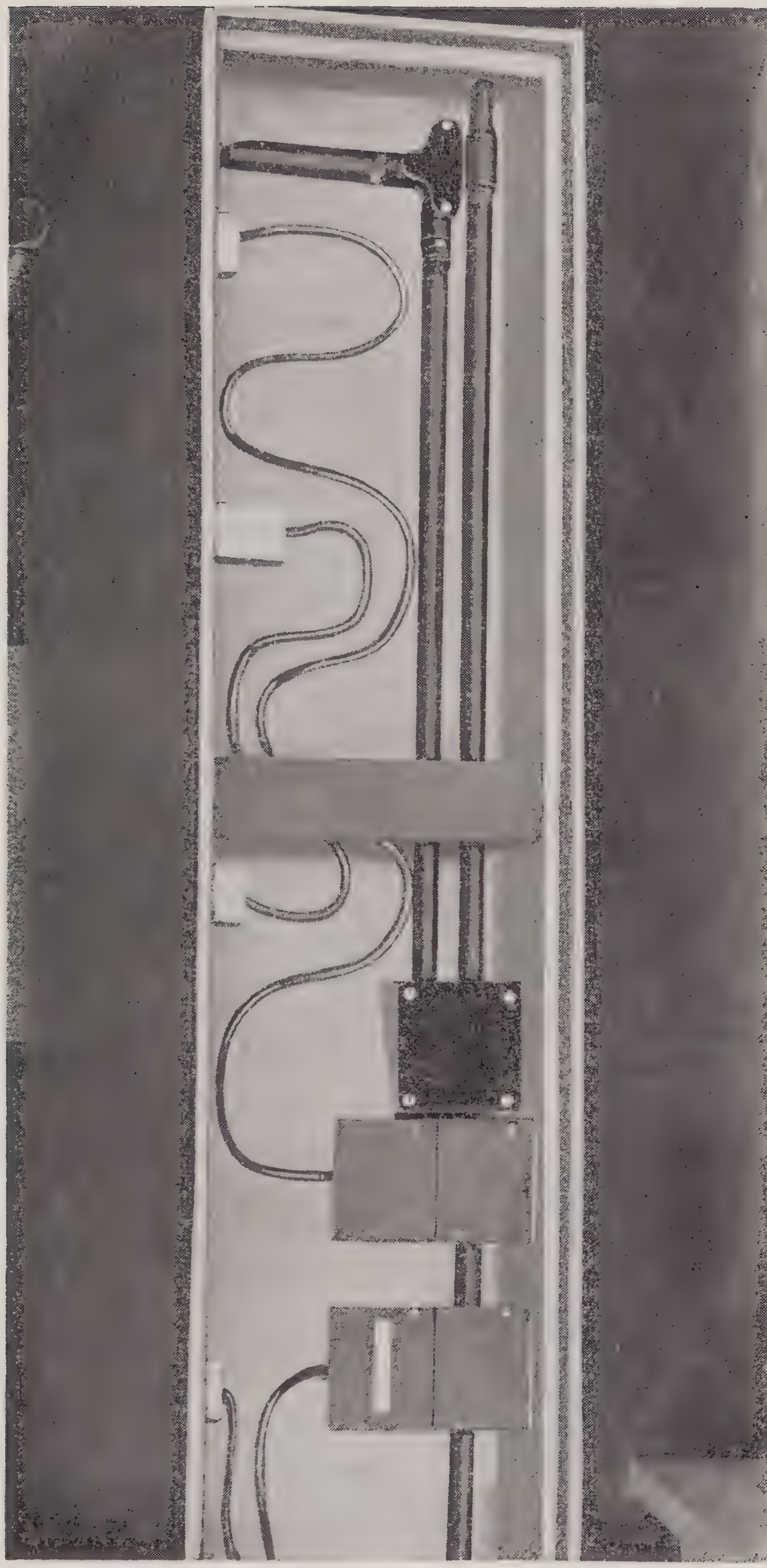


Fig. 4

required standard of warmth throughout the period the supply is not available. Tests have proved that no appreciable drop in the internal temperature of a floor heated building takes place during the five hours following the switching off of the electricity supply.

The lighting installation, electric cooker, and the power plugs are of course connected to the normal electricity supply which is charged at the standard domestic tariff. Each tenant is provided with two electricity meters, one to measure the units consumed by "off peak" use and the other to measure the supply taken for lighting, cooking and other uses.

Water Heating

Although the provision of hot water to the tenants of the flats is quite separate from the space heating system, it is felt that a few details of the electrical water heating system would be of interest.

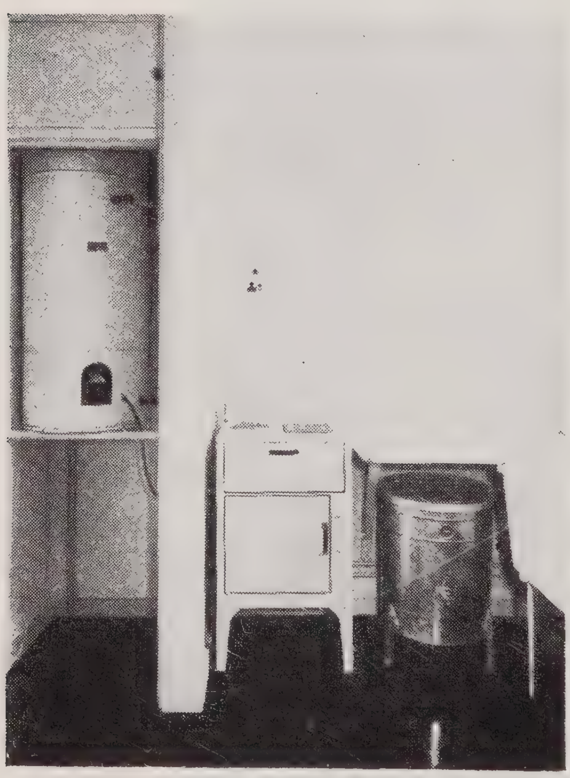


Fig. 5

The electrical water heater is illustrated in Figure 5. It is a 42 gallon cistern type electric storage water heater and contains 30 gallons of hot water. The water heater is connect to the "off peak" supply and t tenant therefore enjoys the benefit the "off peak" tariff for water heati as well as for floor warming. T 30 gallons of really hot water, whi is available every morning, is sufficie to meet the normal household nee until the electricity supply is aga available during the period of t midday boost. The special requir ments of washing day are met by separate electric wash boiler which supplied from the ordinary electrici circuit.

Operating Costs

It is estimated that the annual cos of heating the flats will amount to £ and £19 respectively for the thr apartment and two apartment flat These figures include both the flo heating cost and the cost of providin supplementary heating with electr radiators.

The costs of hot water, cookin lighting, etc., are expected to be abo £22 per annum for a three apartme flat and £13 per annum for a tw apartment flat.

These costs are considered qui reasonable having regard to th benefits that the tenants will enjo without being involved in any expend ture at all for other fuels such as soli fuel and gas.

Advantages of Electrical Floor Warmin

Capital Cost: Electrical floor warm ing can be installed at low cos Moreover, its adoption for a buildin results in substantial savings in buil ing costs, as no fireplaces or flues ar required for the individual dwelling and no boiler-house, boiler, or chimne are required for the building as whole.

The rewireable type of electric floor warming such as that install in the Kirkcaldy flats costs abou £25 per kw, that figure including a associated electrical work. The tot loading of the floor warming installa tion is 148 kw, i.e., an average c just over 3 kw per flat.

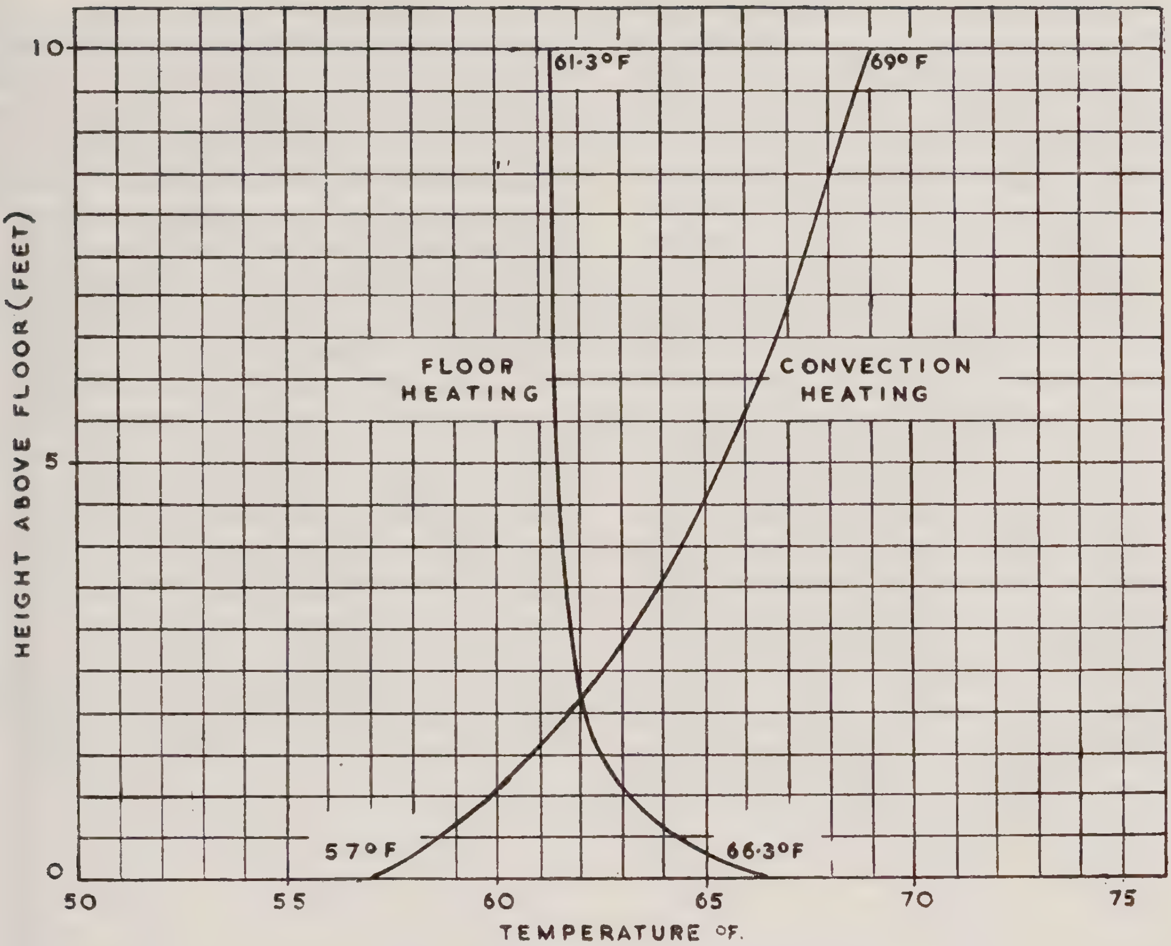


Fig. 6

As already indicated, the electrical heating cables can be directly embedded in the floor with consequent reduction in cost. A floor warming scheme can be installed on these lines for £12 per kw, including all associated electrical work, but such a system has the disadvantage that the heating cable cannot be replaced without breaking up the floor. It should be added, however, that electric heating cables are extremely reliable and the risk of breakdown is therefore remote.

Comfort: Figure 6 shows the result of actual tests taken in a building where both floor heating and ordinary convection heating are installed. It will be noted that, with electrical floor heating, the temperature is greatest near floor level and at a minimum at ceiling level. With convection heating the temperature at ceiling level is much greater than at floor level. Floor warming provides heat where it is most required, i.e., at a person's feet and in addition the temperature is evenly distributed over the room. Floor heating minimizes air currents and this cuts down draughts and increases heating efficiency.

The maximum floor temperature is about 72°F. Almost any type of floor covering can be used and actual results prove that carpet, rubber, hardwood, linoleum, cork and thermoplastic tiles suffer no harm when installed in electrically floor heated buildings.

Cleanliness: Electricity is the cleanest of fuels to handle and to use. No products of combustion require to be dealt with and this, together with the elimination of unnecessary air movement within the building, results in longer life of interior decorations.

As the heating system is buried in the floor, the room space is free from obstructions and housework is made easier.

Labour Saving: A striking feature of electrical floor warming is that it is a heating system that eliminates labour for the housewife and her husband. No trouble is involved in its use and it is fully automatic in operation.

The Future

The Kirkcaldy flats have been built to last many years, and it is important to consider, not only how electrical floor warming compares with other methods of heating at the present time, but also the comparative position twenty or even ten years hence.

At present most of our electricity has to be produced from coal. This position will alter materially as the result of the development of nuclear power. The White Paper published in February, 1955, told of the proposed construction of twelve nuclear power stations during the next ten years, the first two being due to be in operation by 1960-61. In June, the Minister of Fuel and Power announced the proposed construction of six new reactors, which are to be installed at Calder Hall and at Annan, Dumfriesshire, these being additional to the twelve nuclear power stations.

The building of these nuclear power stations is an important step towards solving the nation's fuel problem. For efficient operation, the nuclear power station must operate continuously, night as well as day, and the " off peak " use of electricity will become of increasing importance. Electrical floor warming, along with other " off peak " loads will thus become ever more desirable in the national interest. Although this method of building heating is only just developing, I am confident that there will be great expansion in its use during the next few years.

SMALL-PIPE FORCED CIRCULATION CENTRAL HEATING

by

S. A. Burke, Ph.D., D.I.C., A.R.I.C., M.Inst.F.

A large proportion of the population would probably have central heating in their homes if they could afford it, but so often they are already established in a house by the time they can even consider the cost of central heating, and the expense of installing the conventional gravity system in an existing house is beyond the means of most.

One major reason for this is that the pipes used in a gravity circulation system are usually 1 in. or $1\frac{1}{4}$ in. in size, and are too large to be left unconcealed in a living room. Consequently they have to be buried beneath floors, and are sometimes built into walls also. The return pipes, approaching the boiler at ground floor level, have usually to be sunk into ducts in the site concrete, in order to get past doorways and to permit a slight slope on the pipe for preventing air locks.

The cost of pulling up floors, particularly wood block and concrete ground floors, is considerable, and where tongued and grooved blocks or boards are involved, it is a difficult matter to replace them afterwards in a really satisfactory manner.

When one adds to the costs of

structural work the expense of redecoration afterwards, it is not surprising that many people say they cannot afford central heating. Even in a new house, the cost of building in the pipes under the floors is quite an item, and some architects are averse to weakening of joists by notching for large pipes, as the high present cost of timber restricts joist sizes and the quality of the wood is by no means reliable.

Accelerated systems have been employed, in which the use of a pump or accelerator enables somewhat smaller pipes to be used, but the size of the pipes is still rather too large to be run on the surface of living-room walls. The pumps have sometimes been said to cause undesirable noise at night in a house, and so pipes are often left large enough to give an effective measure of gravity circulation with the pump switched off.

About five years ago B.C.U.R.A. started laboratory experiments with a form of central heating which went one stage further. The idea was to use pipes of such a small size that no concealment within floor or walls would be necessary.

The pipes used in the tests were of $\frac{1}{2}$ in. bore and the resistance to flow was greater than could be met by the accelerator pumps then on the market. New types of pump are now available, however, and complete facilities for testing pumps are in use at B.C.U.R.A. including a soundproof cabinet and instruments for measuring the very small amount of noise emitted. The electric power consumption of these pumps is very low indeed.

The laboratory tests of the small-pipe system were carried out with a thermostatically controlled boiler, which was kept at a fixed temperature, while the central heating could be regulated independently by means of a by-pass and mixing valve (Fig. 1). The amount of interference between central heating and hot water supply was thus reduced to a minimum, and it was shown that with this system both could be provided very satisfactorily for a medium size house (1,000-1,500 sq. ft. area) by a reasonably small central heating boiler of

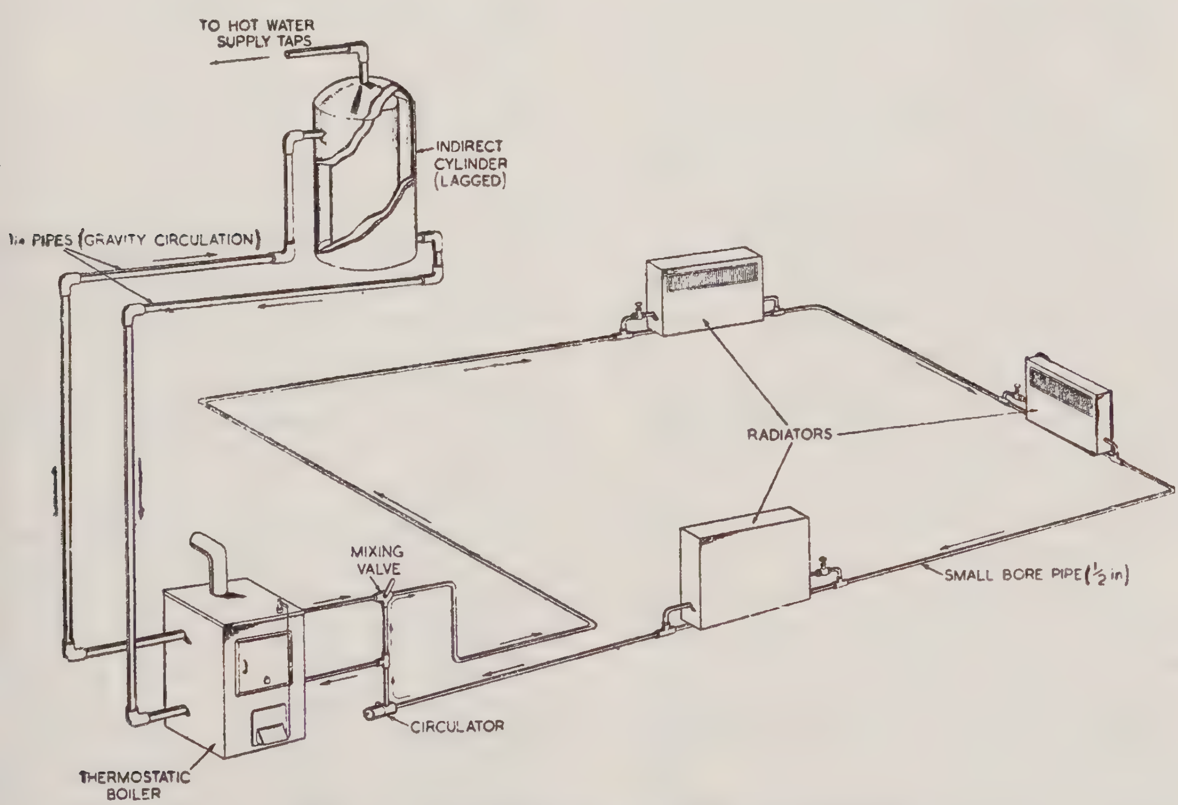


Fig. 1. Diagram showing Basic Arrangement

30,000-40,000 B.t.u./h. rating (7-9 sq. ft. heating surface).

As the central heating is dependent on pumped circulation, the boiler must be connected by gravity circulation to an indirect cylinder, so that if the pump stops for any reason, the surplus heat in the boiler can be transferred to the cylinder during the period in which the boiler thermostat adjusts the combustion conditions. These gravity circulation pipes to the cylinder should not be less than 1 in. diameter.

The main laboratory tests were completed in 1954, and during the winter of 1954-55 two trial installations, one in a house and another in a bungalow, were tested under actual household conditions. By the end of last winter a third installation was in operation. The tests proved that even at night, when the general noise level is extremely low, the pumps could be kept running without audible noise in bedrooms.

Many of the installation problems were met and overcome in these first trials, and a great deal of operating experience was gained. It was found, for example, that brick walls, plastered on both sides, could easily be drilled with holes large enough to take the small heating pipes, if the correct procedure was adopted, and no " making good " of plaster or distemper was necessary afterwards.

Two views of an installation in a house are shown in Figs. 2 and 3. Fig. 2 shows the pump and boiler used in this particular case, while Fig. 3 shows part of the small piping running along a skirting in a bedroom. As this piping is painted to match the woodwork behind, it is quite unobtrusive, and part of it is normally hidden by furniture.

The first trial houses showed clearly that the advantages of the system would be greatly increased if automatic control of the central heating could be applied. Manual control by the by-pass valve shown in Fig. 1 gave much better regulation of central heating than is possible with a gravity circulation system, but it was felt that still better control might be achieved by an automatic regulator, which would also relieve the householder from the necessity for making manual adjustments.

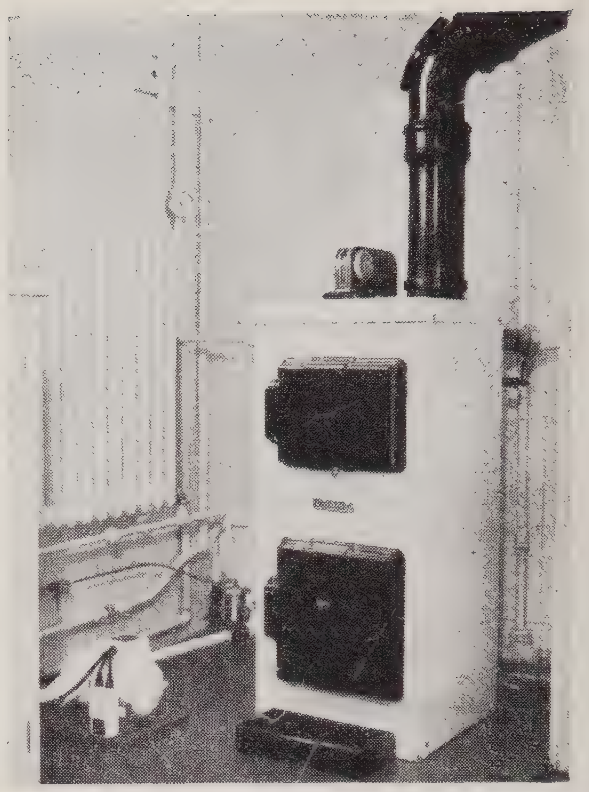


Fig. 2. Pump and Boiler in Trial House

Automatic control equipment is commercially available, and is used in blocks of flats and some houses, but it is too expensive for general household use. In the spring of 1955, however, new and cheaper methods were developed by B.C.U.R.A. and are now being tested. Present indications are that they will make this new form of central heating much more satisfactory in operation. Full details of the work are to be published later this year.

The experience of last winter showed that automatic control of central heating might well lead to appreciable fuel economy, since the heat output from radiators is never greater than is required to maintain the desired temperatures. There is thus no need to throw open windows and waste heat because a room becomes oppressively hot. The steady and dependable

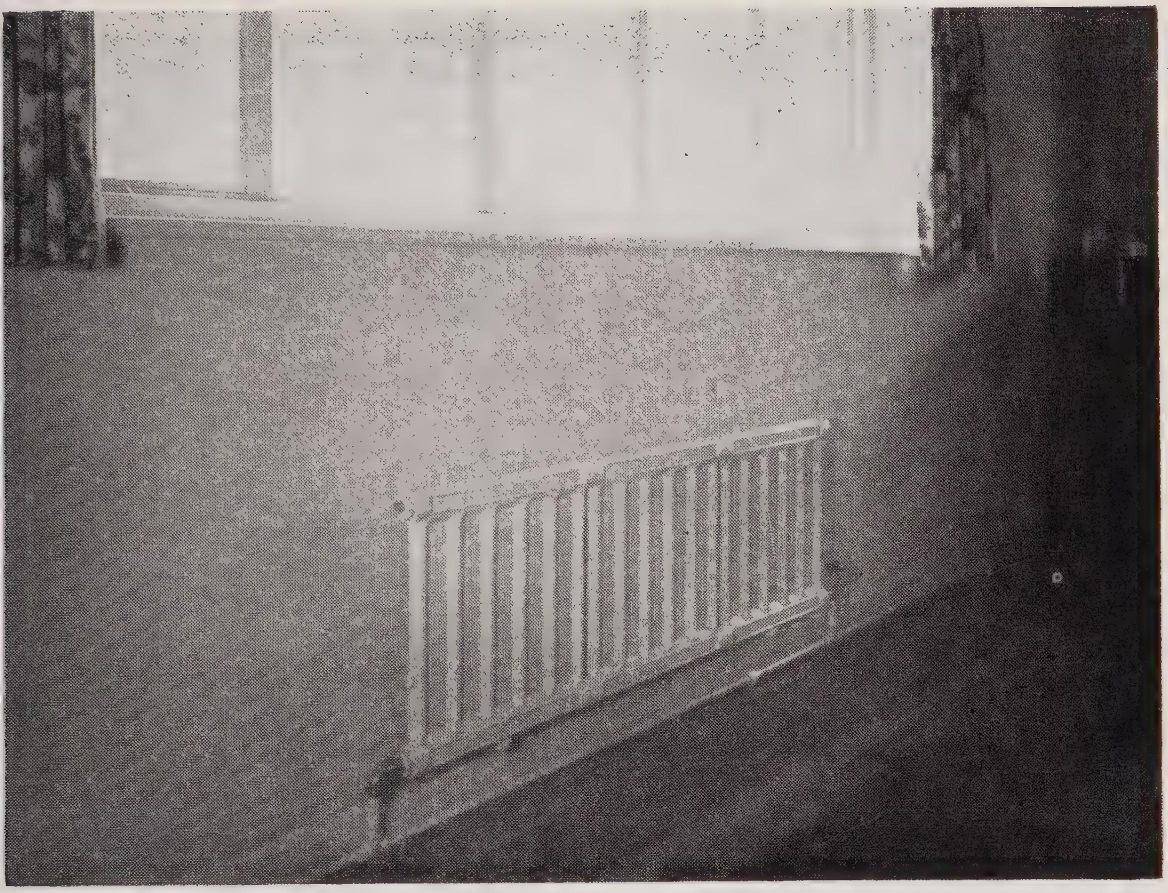


Fig. 3. Radiator and Piping in Bedroom

temperatures are, indeed, one of the attractive features from the user's point of view, and this aspect will be further explored using temperature recorders in the trial houses next winter.

Fuel saving also results from the fact that pipes need not be carried into the roof space, nor below the ground floor. All the heat output from the system is within the living space of the house, and tends to be localized at the radiators in use, since the piping is small. Moreover, all the radiators are at substantially the same temperature, and turning some radiators on or off does not materially affect the others. As with all central heating, house insulation can play a big part in fuel saving, and insulation of the upper ceiling is strongly recommended.

Next winter there will be at least a dozen trial installations operating in the Leatherhead area. Installation costs cannot yet be quoted, but they must obviously be less than those of a conventional gravity system in the case of an existing house. A better estimate of costs will be possible when a number of installations are completed in different types of houses.

Some of the installations are in $\frac{1}{2}$ in. copper tubing, and some in $\frac{3}{8}$ in. (nominal) iron tubing. Each of these has certain advantages for the purpose; in some cases the choice is dictated by technical considerations, whilst in others it is a matter of convenience to suit the heating engineer or builder.

At the present stage it is not recommended that this system should be regarded as generally available, as there is still insufficient experience of the new techniques of installation and automatic control. Certain fittings, and also the automatic control devices, are at present manufactured only in the B.C.U.R.A. workshops, and are available only for the trial installations.

By next year, however, the results of both the laboratory tests and those in trial houses will have been made

available to heating engineers, and the control equipment may be commercially obtainable.

A moderate amount of "background" central heating is essential for a really comfortable house, and provides heat at high efficiency and low cost from smokeless fuel. In view of the limited supplies of smokeless fuels which are available, it is of the utmost importance that central heating systems should be capable of putting the heat only where it is wanted and when it is wanted. The flexibility and controllability of the small-pipe system as well as its piping layout, suggest means by which this may be achieved.

WHOLE HOUSE WARMING BY DUCTED AIR

by

W. Davidson, Ph.D., M.Inst.Gas E., M.I.H.V.E.

Whole-house warming by ducting heat from a "central" source was first introduced by the Romans with their hypocausts. It was re-discovered by our American friends during last century and more recently, re-introduced to this Country. There is therefore, nothing new in the basic principles of the system of whole-house warming by ducted air which I shall describe, but naturally the method of applying these principles has undergone many changes.

The ducted warm air system as we know it, provides a means of heating the whole house and giving a plentiful supply of hot water from a single heater, using no more fuel than was ordinarily used in pre-war days for heating the living room only and providing a comparatively poor hot water supply. Moreover, the gas and oil-fired appliances are completely smokeless in operation while the solid fuel units, even when using ordinary bituminous coal, are virtually smokeless.

To achieve this economy of operation the following conditions must be satisfied:

(1) The house must be insulated to the Egerton Standard (Post-War Building Studies No. 19) so reducing the fuel consumption by 25 per cent.

(2) Over-ventilation and draughts should be reduced by omitting air-bricks in living rooms and bedrooms and by weather-stripping outside doors, so saving a further 15 per cent fuel.

(3) A high efficiency appliance must be used. Those described operate at an average overall efficiency of 75 per cent which is more than three times that of the pre-war open coal fire.

The ducted warm air system

The system is both simple and effective. The heating unit, normally placed in the kitchen, is connected to a system of ducting. Air is drawn by a fan from two or three points in the house, passed through the heating unit where it is warmed to a predetermined temperature, and is then carried in insulated ducts to the various rooms to be warmed.

The chief features of the system are:

(*a*) *Uniformity of temperature distribution.*

The circulating air is drawn into the system through high level grilles and is discharged to the rooms through suitably placed low-level registers.

In this way, very low vertical temperature gradients are obtained and temperatures at the ceiling are

only 3–6°F. higher than those at the floor. The variation of temperature on any horizontal plane is not more than 1–2°F.

(*b*) *Flexibility and ease of control.*

The house temperature is automatically controlled from a room thermostat placed either in the living room or hall. When this thermostat calls for heat, warm air is discharged to the rooms to be warmed. The desired temperatures are quickly attained. The heating to unoccupied rooms is easily shut off by closing the warm air registers in these rooms.

(*c*) *Elimination of Stuffiness.*

To dispel the sense of stuffiness often associated with convection heating, it is not only necessary to provide uniform temperature conditions with low vertical temperature gradients, but some small fluctuation of the mean room temperature is desirable while an air movement of 25–40 ft./min. should be created within the room. The ducted warm air system satisfies both these conditions. There is a temperature variation of approximately 1°F. above and below the room thermostat temperature setting as the heating is automatically switched on and off by the thermostat, and this, coupled with the air movement caused by the circulation of the warm air, gives a sense of freshness which is essential for full comfort.

(*d*) *Freedom from local discoloration of decorations.*

Since the warm air is discharged at low level at a velocity of approximately 300 ft./min. any impingement of the warm air on the wall surfaces is prevented and no local discoloration occurs.

(*e*) *Unobtrusive and space-saving.*

The heating system is economical in space. The warm air registers fit flush on the partition walls or on the faces of the false bottoms of cupboards and do not project into the rooms, thus saving valuable floor space. They can, if desired, be finished to match the walls.

(*f*) *Smokeless.*

Several forms of heating unit are available for the whole-house warming system which are either completely or virtually smokeless in operation. The solid fuel units, even when burning ordinary bituminous coal ($\frac{1}{2}$ in. to 1 in.) give, under normal conditions, an overall smoke emission of less than 0.1 per cent by weight of the coal burned, which is no more than that obtained when burning some types of " smokeless " fuel in the open fire.

(*g*) *Freedom of planning.*

A point of particular interest to the architect is that the whole-house warming system is in no way restrictive to planning and he may, if he wishes, adopt the " free " or " open " plan.

Figure 1 shows a typical example of the " open " plan. The whole of the ground floor area, apart from the kitchen and small entrance lobby has been left open as a single and there-

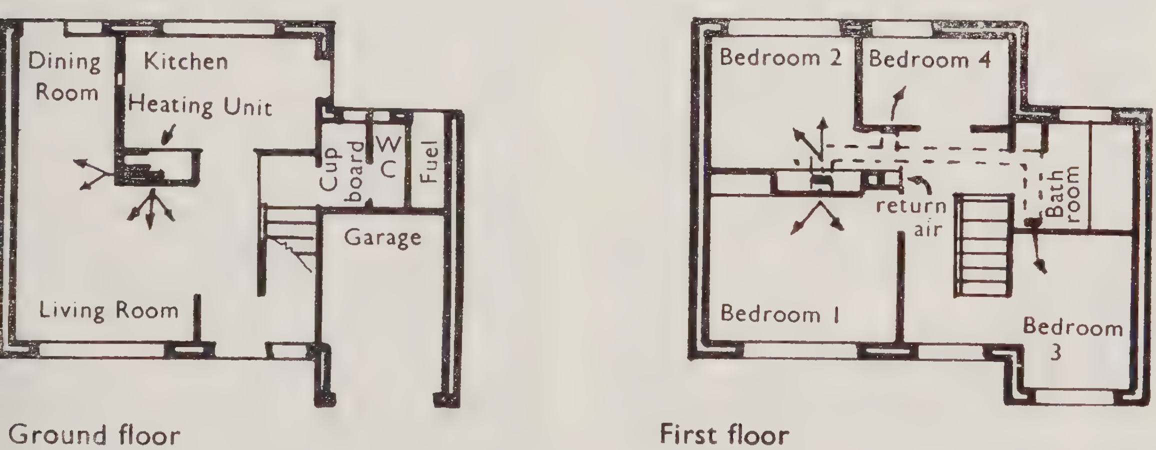


Fig. 1. L.C.C. House. *Architects: S. Howard, L.R.I.B.A., Cyril H. Walker, O.B.E., M.C., F.R.I.C.S., F.R.I.B.A.*

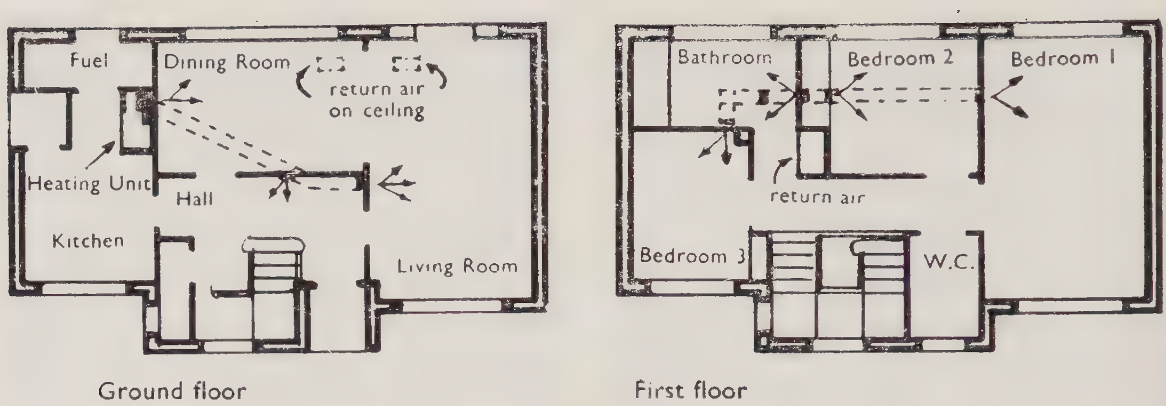


Fig. 2. Traditional House. *Architect: James F. Butler*

fore large living space. The useful space is further increased since the bedrooms can be maintained at comfortable temperatures when required for children's homework, hobbies, or other occupations needing concentration away from radio or other distractions. The whole house, therefore, becomes useful living space.

With the "open" plan, a very simple layout is possible and ducting is kept to a minimum. The heating of the large living room is very uniform, and no draughts are caused by taking the stairs off the living room.

Figure 2 shows a more traditional plan with separate entrance hall, while the lounge and dining room may be opened up to give one large space when desired. With this plan, warm air is carried from the base of the unit in an insulated duct formed in the concrete floor slab, and is discharged through low level registers to the hall and lounge.

If a board and joist ground floor construction is adopted, a lagged metal duct is run in the underfloor space. From the top of the unit warm air is taken in lagged metal ducting (accommodated where possible between the joists) to the registers in the bedrooms and bathroom.

Partially-ducted and non-ducted warm air systems

The ducted air system of whole-house warming has been applied mainly to higher and middle income group housing, but attention has recently been given to the provision of partially-ducted and non-ducted systems for the smaller local authority house of 750–1,000 sq. ft.

These simpler systems are designed to provide full heating to the living rooms, and background heating to the bedrooms by discharging warm air to the hall and allowing it to spill over to the landing and bedrooms through the partly open doors.

In the open type of plan where the stair leads off the living room, the non-ducted warm air system can provide full heating to the living room and background heating to the bedrooms by spillover.

With each of these systems, topping-up to full comfort temperatures in the bedrooms is most conveniently provided when desired, by gas or electric fires.

Appliances

(*a*) *Whole-house warming — fully-ducted.*

Solid fuel, gas and oil-fired appliances are available and these have ratings of 35,000 to 50,000 B.Th.U/hr. They are capable of providing full comfort conditions in houses from 1,500 to 2,000 sq. ft. total floor area when these are insulated to the Egerton Standard.

Each appliance is thermostatically controlled and provides the required services at average operating efficiencies of 75 per cent. The gas and oil-fired appliances are completely automatic in operation requiring only the setting of the room thermostat to the desired temperature.

Reference has already been made to the low smoke emissions obtained

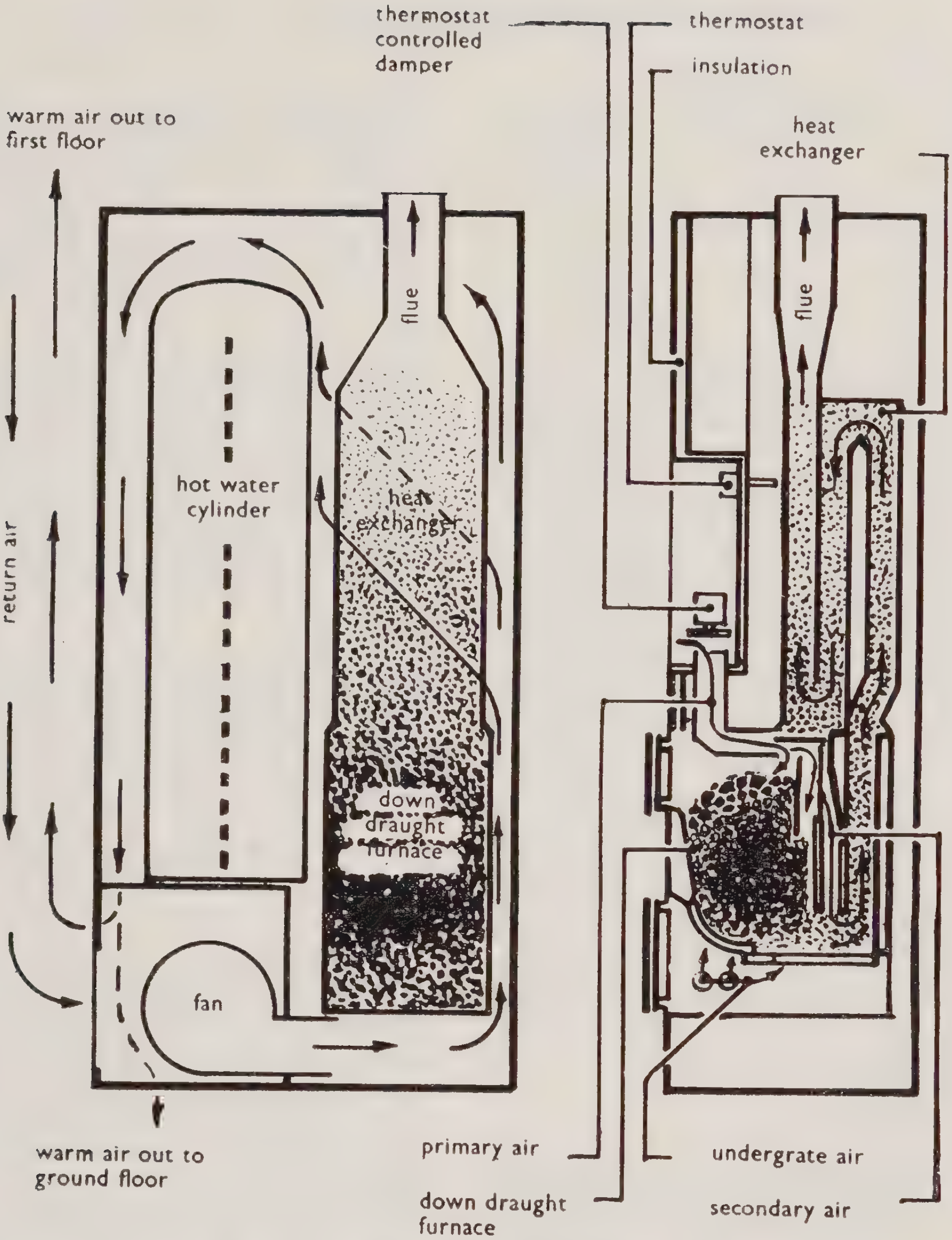


Fig. 3. Front and side sectional diagrams of the Solid Fuel Heat Unit

rom the solid fuel unit when burning rdinary coal. This is achieved by sing a down-draught firebox (See igure 3).

) *Appliances for partially-ducted and on-ducted warm air systems.*

The space heating outputs of the ppliances required will vary between 5,000 and 25,000 B.Th.U/hr. while pproximately 50 gallons per day of ot water at 140°F. at the tap will be eeded.

A solid fuel appliance suitable for ther the partially-ducted or non-ucted system was described by Dr. arold Hartley in his Paper, " Domestic Solid Fuel Appliance Design and the Beaver Report " presented at the Convention of the Coal Utilisation Council in April, 1955.

This appliance, like the whole-house warming unit referred to earlier, has a down-draught firebox and burns coal with the same low smoke emission. The unit also burns smokeless fuels. It provides space heating, water heating and cooking with a thermal efficiency of 75–80 per cent.

Mention should also be made of an indirect warm air heating unit used

Annual Fuel Consumptions for Space and Water Heating

floor area of house sq. ft.	*Solid Fuel Unit*		*Gas Unit*	*Oil Unit*	
	Solid fuel Tons	*Gas Therms*	*Therms*	*Oil Gallons*	*Gas Therms*
1,000	4	90*	850	600	90*
1,500	5½	90*	1,050	850	90

for the non-ducted system. With this, a heating cabinet is placed in the living room of the "open"-plan house and is connected to a hot water boiler usually placed in the kitchen. The cabinet contains a water-to-air heat exchanger and fan, hot water at constant temperature being supplied by the boiler to the heat exchanger.

The space heating is automatically controlled by a room thermostat which operates the fan in the cabinet heater. Air is drawn through the cabinet over the heat-exchanger coils and the warm air discharged to the living room. Full heating may thus be provided in the living room while the spill-over warm air provides background heating to the remainder of the "open"-plan house. The boiler also provides domestic hot water.

Fuel consumption

Using the solid fuel, gas or oil-burning appliances with the whole-house warming system described, the approximate annual fuel consumptions are given for houses of 1,000 and 1,500 sq. ft. total floor area, insulated and ventilated according to the recommended standards.

The consumptions given will maintain the whole house at 55–60°F. at all times, the lounge and dining room at 67°F. for 8 hours per day and the bedrooms at 65°F. for 4 hours per day, and also provide 50 gallons per day of hot water at 140°F. at the tap.

The consumptions given are for a very high standard of heat service, far above that normally "enjoyed" by the majority of people in this country. It is true that with the continued rise of fuel prices most of us will be unable to afford these very high standards.

The systems described however, give us a means of getting the maximum heating value from the fuel we are allowed or can afford to buy since the flexibility and automatic control is such as to enable us to adjust the output to our requirements.

User reaction

No mention has been made of the reactions of users to the whole-house warming system. References are often made to the Englishman's love for the open fire and many believe that he will never be weaned away from it. Experience does not support this view.

A large number of ducted warm air installations were made in middle and higher income group houses on several housing estates, and since the costs had to be kept to a minimum, no open fire was fitted. The tenants of these houses paid a higher rent than for similar houses with open fire heating. After experiencing the many advantages of the warm air system the tenants do not wish to return to the open fire method of heating. They quickly adapted themselves to alternative focal points such as the television set, and instead of clustering round the fire on a winter evening, they sit in any part of the large living room enjoying full comfort.

In private architect-designed houses, an open fire is sometimes fitted in the sitting room, but this is used less and less as the appreciation of the ducted warm air system increases.

The Author would like to express his thanks to the National Smoke Abatement Society for their invitation to contribute this Paper.

Discussion

Dame Vera Laughton Mathews, in her ntroduction from the Chair, said that she was very glad that the session on Recent Progress in Domestic Heating by Centralized Methods had been included n the Conference. It was a subject that everyone interested in Clean Air must want to know more about—except for he few who knew all there was to know already. She was certainly not included among those, but already, through reading hat afternoon's papers, and cogitating on some of the points raised, she knew more han she did a week before.

Quite apart from the important national ssues involved, she thought everyone responsible for running a home must be nterested in central heating, for the very obvious advantage it brought of comfort without labour. In these days of rush, whether one's work was inside or outside he home, one grasped gratefully at anything which would save time and rouble.

An interesting example had come recently from the National Council of Women, the largest women's organization n the country, which claimed to speak n the voice of several million women. To mark its Diamond Jubilee that year, he Council had undertaken the building of a house which would be occupied successively by women who had given outstanding service to the country. A questionnaire on the planning of the house had been completed by branches of he National Council of Women and affiliated organizations and it was notable hat, for warming the house, central heating by solid smokeless fuel obtained he greatest support. The supposedly popular open grate was not the most favoured form of heating. No doubt labour-saving was an important motive, but they might hope that women's organizations were also becoming clean-air conscious.

It was not reported whether the women concerned had had any indication of comparative cost; indeed that might be one of the occasions—in the case presumably of an elderly occupant—when expense was less important than other factors—but that was not always so.

Dame Vera said delegates would remember that in the survey carried out by the Egerton Committee, in over 5,000 homes, a large majority had favoured central heating, but in reply to another question, it had been made clear that very few wished to pay an economic price for it.

The papers in the session covered a very wide field, and the views and experiences put forward represented a local authority, a fuel producer, a research organization, and an appliance manufacturing organization. Delegates had before them a District Heating Scheme in which the bulk heat was produced at a power station and was used to provide space heating and hot water to some 2,250 dwellings; two systems in which there was a single appliance installed in the house to provide heating service, one system using warm air and the other hot water radiators; and there was an individual house system in which the domestic hot water was provided by an appliance separate from the house warming unit.

Emphasis was laid on new housing. In fact, only the Small-Pipe Forced Circulation system was put forward as an advance in heating installation design to provide for existing housing; that was quite a point, as there were of course some 14 million individual dwellings in existence, of which only some $2\frac{1}{2}$ million were publicly owned.

All the heating methods brought forward for discussion had the same aim, the elimination of smoke with increased comfort in the home. They, at the Conference, were concerned with the reduction of smoke, but no one would deny that the second aim of comfort in the home was also an important national question. Delegates should have in mind not only the methods described that day, but other variations and combinations which aimed at producing those two results.

One aspect which must be prominent in the minds of delegates was that the best use must be made of the nation's available fuels.

On that score, Mr. K. T. Spencer, Chief Scientist of the Ministry of Fuel and Power, had sounded a warning note only the previous week, when speaking at a London Press Conference. He said:

> "Nuclear energy is not going to make much contribution to the space heating of the ordinary home for many years. Scientists and technicians have given the impression that atomic energy is just round the corner and that it would be the solution to our fuel

problems, but even when all the electricity is obtained from nuclear energy, it is unlikely that it would be used for main space heating for economic reasons. . . . The chief smokeless fuels that could be bought at a reasonable price are the solid type, and the biggest volume of that would be coke."

Another essential factor in a heating system was that it should be economically suitable in terms of both capital and running costs. Dame Vera said that she had been told, she did not know if it was true, that it was difficult to know what District Heating Schemes really cost: that under Local Authority accounting systems it might happen that expenses were partly hidden in other costs.

She imagined that the Pimlico scheme was probably the best existing example of a District Heating Scheme, but it had initial advantages—they hadn't all got a power station next door and, if there wasn't one, that fact must profoundly affect the commercial soundness of the system.

Another point from the economic side was that such systems probably demanded "topping up" in very cold weather. If so, who was to supply it? It couldn't be an attractive proposition to those who had to lay mains or cables.

For the private individual, from the purely personal point of view, it was largely a matter of comfort *v.* cost.

Could they afford to heat a whole house all the time? Dame Vera said she noticed that more than one of the papers that day referred to the fact that more comfort was provided than the householders would generally treat themselves to if it were left to individual choice.

Some would hold the view that with the rising standard of living the aim should be to provide full comfort conditions at all times.

Another view could be that private individuals, local authorities, and even governments, might need to "cut the coat according to the cloth," and aim at obtaining a sufficient, but lower, standard than "full comfort"—a standard whereby one room was fully heated and the rest of the house had intermittent heating which could be turned on and off easily, with hot water supplied in the same way.

Dame Vera concluded that the session was certainly one to stimulate thought, and delegates all looked forward to hearing the authors and the discussion they provoked.

Dr. F. J. Eaton (Deputy Manager, Watson House), in opening the discussion, said:

The five papers presented to us this afternoon give information on four very different systems of domestic heat service. All of the systems are, relatively speaking, new to this country in application, if not in principle; they are on trial, and whether they become generally accepted or not, largely depends on the answers they provide to three fundamental questions. These are, I suggest: (1) does the standard of service satisfy the householder? (2) are the capital and running costs reasonable, and (3) is the system suitable for the type of building under consideration? To these basic questions we of the National Smoke Abatement Society would all add an overriding question: "Is the heat produced smokelessly" and fortunately for them all the authors have satisfied us on this point. I now pass to the answers to the three questions found in the papers, many of which can be checked from other sources.

Alderman Russell tells us quite frankly that the tenants had to get accustomed to the new type of heating but are now satisfied with the increased heat service which covers the hours of 6 a.m. to 11.30 p.m. This is confirmed by press reports of the Tenants Association's meetings. We are also told that "a great deal more heat was being consumed than had been expected." Now the design figures were—space heating 357 therms, water heating 178 therms, total 535 therms. Can Alderman Russell give us the heat input that has been found in practice to satisfy the tenant? Dr. Weston, in his paper, "Heating Research in Houses" has stated "the heat requirements of a well insulated house of about 900 to 950 sq. ft. for district heating are likely to be at least 700 therms for an average year in southern England." This is a basic design figure on which running costs and size of heating unit depend. Is it confirmed at Pimlico?

On capital costs, we find a total figure of £300,000. The total number of flats including the 1,200 of Dolphin Square is 3,111 and the cost is thus about £100 per flat. It should be appreciated that this does not include the purchase nor the installation of the radiators in the flats, which other communications have indicated, are classed as a building, not a heating scheme charge, and at Dolphin Square they were already installed.

The financing of a district heating scheme must of necessity be long-term

or the houses are erected after the cheme. This means a deficit in the arly years. The 1955 deficit of £9,000 mounts to 2s. per week per average-sized lat, if, as is likely, Dolphin Square pay he present cost figure. A period of 0 years is necessary to pay off arrears; neanwhile the present tenants are apparently being subsidised.

On pages 5 and 6 of his paper, Alderman Russell sets out five advantages and wo possible disadvantages of the Pimlico scheme. All will be agreed with the mportant exception of the estimated igure of 11,000 tons of coal saved per nnum. This figure is expected from ,200 dwellings or 3.4 tons per dwelling. My personal doubts of the accuracy of his figure are based on Ministry of Fuel nd Power Statistics as quoted in the Gas Council evidence to the Ridley Report. This shows that 61.9 million tons of coal vere used domestically in 1951, either as oal or in terms of coke, gas and electricity. The generally accepted number of households in this country is 12 million, naking roughly 5 tons per household for ll purposes, lighting, heating and cooking. For heating and hot water the figure vould be an average for all houses, large nd small, some 4.2 tons. Thus heating nd hot water at Pimlico appear to be obtained for an average coal consumption of 16 cwts. per annum! Coal conservaion is vital and it is thus important to know how this figure of 11,000 tons aving was calculated. If the comparison s based on an open coal fire scheme, the vhole house heating efficiency of this hould be taken as 50 per cent., a figure given by the Abbots Langley experiments, nd not the figure of 20-25 per cent. which efers to room heating only. Further, it s not clear what saving has been attributed to the Dolphin Square flats. Mr. Donkin, p. 11, gives the efficiency of he district heat input of Dolphin Square s 77 per cent. The boilers previously heating Dolphin Square were of a type imilar to those installed and tested at mperial College by Dr. Livingston Smith nd Dr. Lander. The efficiency was found o be 74.6 per cent. If there is any saving of coal I suggest it will be small but here again could we please have the basis for he calculations.

The success of the Pimlico scheme is, suggest, dependent on the adoption of he heat-electric system. Other district heating schemes employ heating boilers, nd the twelve such schemes operating n this country have not proved so uccessful. Indeed if the accounts in the local press of Council and Tenants' Association meetings are correct, all are sorry they ever embarked on the schemes. There may be some present today who can tell us at first hand their experience of some of these schemes. One last question on district heating: "Can the authors from their experience say that such schemes must be of the heat-electric type?" I feel an answer is needed to establish this point if only to clarify the doubt raised in the minds of all of us by the Minister of Town and Country Planning when asked in the House of Commons on what grounds it had been decided that district heating schemes should not be proceeded with in new towns. The reply then was (*Hansard*, 25th July, 1950) "Because I was satisfied it would not pay."

In his paper on electrical floor warming, Mr. Moule gives the installation costs as £75 per flat and the running cost as £24 and £19, for the three and two apartment homes respectively. The Borough of Kirkcaldy has recently issued a booklet which gives further details of the scheme. The estimated running cost for the three apartment home is given as 14s., of which 4s. 9d. is for hot water, 6s. 5d. for floor heating and 2s. 10d. for the extra electric radiator. The latter heating will be at full cost per unit and only the former at off-peak rates. Although electric floor heating has been used for schools and other buildings, the Kirkcaldy and Inverness schemes are pioneers in its application to Council flats. The researches of J. B. Dick on the heating of schools, and of E. M. Ackery of the Electrical Development Association, indicate that electrical floor warming is an expensive form of heating. This is fully appreciated by the Kirkcaldy Council, for their brochure concludes "It remains to be seen how far these estimates compare with consumptions in practice and how the tenants view the system." I understand tests are to be made this winter and we look forward to having the results.

Dr. Burke has told us quite frankly that the small pipe forced circulation central heating system has passed its laboratory development stage; two installations have been in use for a heating season; at least a dozen will be operating this year but "at the present stage it is not recommended that this system should be regarded as generally available." The paper is valuable in that it gives us advance information—we now know what stage has been reached and that B.C.U.R.A. will soon be able to provide

further information.

Warm air is widely used in this country in the heating of hospitals, theatres, cinemas, etc., but until Messrs. Radiation Ltd. introduced their Whole House unit the system had not been applied to any great extent to domestic house heating. As Dr. Davidson points out, the efficiency depends on intelligent use on the part of the householder. Special care in designing the system is also required in the positioning of the air inlets and extract ducts to suit the house plan and to avoid undue temperature gradients. The heating unit, Fig. 3, is a most interesting one, particularly the method of water heating and the smoke reducing firebox, and it has the advantage of a high overall efficiency of 75 to 80 per cent.

Dr. Davidson has provided us with a most interesting table of fuel consumptions for the solid fuel, the gas and the oil-fired units. Could he please amplify this table first by giving the spread of fuel consumptions for different households. With other forms of heating the spread is considerable. Secondly, could the thermal value of the solid fuel and oil be given? From assumed calorific values I find gas 850 therms, oil 1,000 therms and solid fuel 1,200 therms, thus emphasising the flexibility and controllability of gas firing.

In opening this discussion I have set out to analyse the data presented to us. In doing so I have found it necessary to ask a lot of questions which I hope the authors will answer.

Might I conclude by saying to the authors " Thank you for the information you have given, but could we please have more?"

Dr. W. C. Turner (Chelsea) congratulated the speakers on the excellence of the papers, particularly with reference to the heating schemes in Westminster and Kirkcaldy, as they marked an outstanding stage in the development of smokeless domestic space heating, where it was applicable in new buildings.

There were one or two special aspects which emphasized that importance.

Dr. Turner went on to say that coal costs were rising and that there were shortages, and, for the first time in their history, coal imports exceeded exports, and supplies of smokeless solid fuels were inadequate even for existing premises.

Gas Boards were experimenting with complete gasification of coal, and they were actually producing gas from petroleum products; on the other hand, they were constructing plants which would produce nothing but coke, any gas produced being used in the carbonizing process. Where was all that leading them?

Electricity production was increasing, with surplus heat as a necessary by-product. The coal-burning power stations were specially designed to convert inferior coal into electrical energy. Hydro-electric sources were being exploited, and there were continental links to take up surplus electricity. Now there were nuclear reactors already under load; therefore, the more electricity produced and used, the more waste heat there would be available for district heating schemes.

The point Dr. Turner really stressed was that local authorities were now the largest landlords. They were about to embark on widespread slum clearance. The new buildings erected would stand for many generations, but unless there was a radical change of policy, they would perpetuate their enslavement to conventional, relatively inefficient solid fuel appliances. It had been shown that electricity, either directly or through waste heat accumulators, was the only fuel which showed any likelihood, in the future, of becoming cheaper in relation to other fuels. Now was the time for the British Electricity Authority to give a lead to encourage the installation of plant for the off-peak take-up of electricity for space heating.

Dr. Turner further stated that electricity, including thermal storage, and gas should not be competitive forms of heating, but complementary. If smokelessness was an amenity which they desired, they must pay for it. Nobody at the present day seriously objected to charges made for pure water and sewerage.

One point about the Kirkcaldy scheme was that it was entirely under the control of the tenant, in that he could switch it off if he did not want to use it.

Dr. A. Parker (Fuel Research Station) said that all the methods of space heating described by the authors of the several papers would have their appropriate application according to the particular circumstances and household needs. There were districts in which district heating, from thermal-electric stations or from central boilers, would be the right choice. For most households in this country, however, systems of individual house heating would be preferable for various reasons; but the system chosen would depend on the family needs and to

vhat extent the householder was prepared o pay for comfort and convenience.

With regard to the paper by Alderman Russell, he would be glad of an explanaion how the estimated saving of about 1,000 tons of coal per annum had been alculated for 11,000 people living in ,200 or so dwellings. The average fuel onsumption in the country for domestic eating, hot water, and cooking was about ⅓ tons of coal per person per year, ncluding the coal used in providing the oke, gas and electricity consumed. Deducting the fuel used for cooking, gave n average of less than 1 ton of coal per erson per year for space-heating and hot vater. It was difficult to understand, herefore, how the district heating scheme escribed could save 1 ton of coal per erson per year. The only true measure of elative fuel consumption would be the uel used for space heating and hot water y the district scheme in comparison with he fuel for the same comfort with a ousehold coke boiler operating at say 0 per cent. efficiency. Central heating y radiators should not be compared vith radiant heating from open fires.

A. C. Hazel (Hurseal Ltd.) said that the ther speakers had submitted various lternative methods of providing comrehensive central heating schemes and heir contributions were of interest from he point of view of a much higher andard of comfort for everyone, though he fact remained that if everyone adopted he methods suggested by the platform hen, of course, they would merely be ggravating the domestic fuel problem. The present-day problem was not how hey could use more fuel and enjoy a very uch higher standard of comfort; it was hat they must use less fuel though, if ossible, they wanted a slightly higher andard of heat comfort, but the mphasis must be on using less, and that eant that the great mass of the populaon would probably use their heating quipment intermittently.

It was customary at such Conferences o condemn the open fire and Dr. Davidon, in his remarks, had taken that line f action. It was true that the ordinary pen fire was a most wasteful form of eating, but the new free standing fires f the adaptor type were twice as efficient s the old and, what was more important, hey could be used intermittently—in fact rned on an off like a gas fire. That eant that the great mass of the people ould enjoy the tremendous advantages of an open fire, using smokeless fuel of course, and at the same time have a higher standard of comfort.

However, it was important where smokeless fuel was concerned for intermittent heating, that the fuel should be easy to ignite. In fact, in his view the most important feature of a smokeless fuel must be its ignitability and flexibility. In the same way, the most important feature of any appliance, be it solid fuel, gas or electricity, should be its flexibility. In other words, in the case of electrical appliances, they should be thermostatic and time switch controlled so that no fuel was wasted. In the same way, with solid fuel appliances, the room air change must be reduced to the minimum and it must be possible for the householder, at the touch of a switch, to reduce or increase the rate of burning of a fire.

In the case of the central heating schemes advocated by the platform, there again it was very important that all central heating schemes should be designed for intermittent use, as well as continuous use. One of the great virtues of the system advocated by Dr. Burke was the fact that with small bore pipes and the use of pumps one could have a system which could be turned on or off almost at will. One of the disadvantages of the floor heating advocated by Mr. Moule was the difficulty of controlling that form of heating.

Electricity was a wonderful fuel but should only be used, in his view, where it could be easily controlled.

Finally, it was very important that everyone attending the Conference bore in mind that any expert speaking on behalf of a particular fuel producing industry would naturally make the case for his own fuel to the best of his ability. There was a place for all fuels, but delegates must not allow themselves to be influenced too much in any one direction. They must bear in mind that probably, in the homes of the future, the tendency would be to use more than one fuel, and that would not of necessity be a bad thing. All one should insist upon, regarding the use of any fuel, was that the appliance in which it was used should be the most efficient possible, that the appliance should be capable of being turned on and off as required, that it should be possible to reduce the rate of using the fuel to the lowest possible figure, so as to achieve the maximum economy, and that the cost of operation should be within the reach of the ordinary householder's pocket.

Councillor T. Hewlett (Walton-le-Dale) said that having listened carefully to the speakers from the platform on fuel burning, etc., it appeared to him that the essential factor—cost of fuel (be it gas, electricity, coal or coke)—was lost sight of, and unless fuel could be produced at low cost, the fine ideals coming from the platform would go by the board. He said that his Housing Committee had recently turned down an attractive offer from the North West Electricity Board to install immersion heaters in new Council property because they feared the temptation to the housewife to use hot water freely would land her in the position of being unable to pay her electricity bill.

F. J. Forty (London), *in a written contribution*, said that he had gathered that a remark of Alderman Russell, when introducing his paper on the Pimlico District Heating Scheme, had been taken as criticism of the City of London in relation to their non-adoption of a district heating scheme for the devastated areas of the City. The implication had been, at the microphone, refuted by Mr. McGrath, Chief Sanitary Inspector of the Corporation, but in addition to his remarks, Mr. Forty thought it desirable to make some observation upon Alderman Russell's comment.

It was not appropriate to make a comparison between unlikes, as represented by the compact Pimlico Housing Scheme, fortuitously endowed with various characteristics highly advantageous to a district heating scheme, and the quite dissimilar devastated area of the City of London. By anyone mentioning the Pimlico Heating Scheme as an example of District Heating, it should, he considered, always be borne in mind that this scheme was capable of realization only by virtue of several most favourable existing conditions. In order to illustrate his contention that the Pimlico Scheme, notwithstanding its success, which he did not for one moment dispute, could not be considered as a typical illustration of the applicability of district heating, either generally or in other unlike cases, he would compare the conditions referred to with those generally found when District Heating was considered and in particular when considered in relation to the City of London. The conditions to which he referred in respect of the Pimlico Heating Scheme of the City of Westminster were as follows:

1. The position of an existing power station immediately across the River Thames opposite the Pimlico Housing site, and the proposal promoted by the British Electricity Authority to extend the station by the provision of back pressure boilers, which would produce sufficient surplus heat for the needs of the heating scheme.

2. The existence of a tunnel beneath the Thames, which crossed the river opposite the power station, and the willingness of the owners of that tunnel, namely, the Metropolitan Water Board, to allow space in it to be used for the housing of the hot water flow and return mains.

3. The limiting extent of the heating scheme being that of a housing development entirely under the control of the Local Authority, namely, the City of Westminster, which ensured building development phased to the needs of the heating scheme as well as other requirements.

4. Finally, the existence of a large commercially developed housing scheme, namely, Dolphin Square, being sited immediately adjacent to the Pimlico Housing Scheme, allowing a further and simple extension of the heating scheme after the owners had indicated their willingness to be a party to the project on terms beneficial to the Authority.

As the above four conditions were quite fortuitous, it was, in Mr. Forty's view, unrealistic to compare its success or otherwise with district heating as generally requiring to be considered, and that was why he took the opportunity not only to present the facts given above as he saw them, but also to compare them with the extensive and protracted negotiations his Authority had carried out over a period of some three years for the purpose of ascertaining whether district heating could be introduced into the City of London as a part of the post-war development plan. In that connection, the Corporation had had the advantage of a comprehensive report from Mr. S. B. Donkin, M.I.C.E., on the possibilities of establishing a district heating scheme to provide 250 acres of the City which had been subjected to severe war damage, with a system of space heating and hot water by means of thermal electric generation. In Mr. Donkin's proposals one-third of the economy of the scheme had been dependent upon the Corporation selling to the British Electricity Authority the electricity generated from power stations to be erected by the Corporation and resulting from the generation of heat

rom back pressure boilers. That method ad been proposed, because at the time he project was considered, namely, 947-1949, the British Electricity Authoity had been engaged upon a priority rogramme of post-war development of ower stations required to meet an ncreasing electricity demand to the xclusion of any proposals in the form of hermal electric generation. There had een, therefore, no question of obtaining eat from that source even if a readyade tunnel had been available.

It had also to be borne in mind that in onsideration of a scheme of that nature, ontrol over the areas to be developed ould be necessary, in order to ensure hat such development was related to the eating system. The manner of developent of post-war building in the City uring the period 1947-1952 had borne ut the contention at the time the matter as considered, namely, that development would occur in small pockets spread ver the entire area of the City, making completely uneconomic to provide a eating system which was based on eneration from a central source with istribution by underground mains to the ources of demand.

An expenditure of over £7,000,000 was volved and estimated to require 15 ears to develop, and after the most areful consideration the Corporation ad decided that it was not a project hich they were prepared to approve, articularly as the sale to the British lectricity Authority of electricity on a ng-term basis was not a proposal which at Authority could entertain.

Subsequent to the Corporation rejecting e development of a district heating heme for some 250 acres of the City, strict heating in the form of group eating had been very carefully condered and research into the possibilities that method of heating carried out over further period of 12 months. The ain conclusion arrived at following at investigation was that development group heating in the City could only a practical and economic project if a pply of heat was received from the itish Electricity Authority in the form surplus heat from one of their power ations.

Following an approach to the British ectricity Authority in respect of their uth Bank Power Station, it had been certained that although it was technilly possible to provide saleable heat from power plant using oil-fired boilers, as adopted in the South Bank Station, the Authority's engineers were of the opinion that it would be too expensive to market surplus heat commercially. That power station, therefore, being excluded as a possible source of heat, the Corporation had come to the conclusion that group heating schemes promoted by themselves would not compete successfully against modern central heating systems installed by developers in buildings designed on a comprehensive development basis which was the predominant method of post-war building in the City.

Since consideration of those schemes, Mr. Forty said he had had several further talks with representatives of the British Electricity Authority on the anticipated development of building in certain selected areas in the City, to ascertain whether, within a more limited way, the possibility could be considered of developing a nearby power station with a view to supplying surplus heat for sale to developers. Although those considerations had been proceeding for several years, up to the present time, as far as he was aware, the British Electricity Authority had not yet reached a conclusion whereby development on those lines could be shown to be an economic proposition.

Finally, Mr. Forty said he found it difficult to believe that there could ever be a suggestion that in anything connected with that particular subject, the Corporation of London should be referred to by a neighbour as apathetic. The support given by the Corporation to the cause of clean air was well known. The work done by the late Sir George Elliston, both as a member of the Corporation and as President and a most enthusiastic supporter of the Smoke Abatement Society, was so familiar to those who had an interest in the matter, that it was difficult to understand that there could be a neighbour who was unaware of it. There was no stronger protagonist of the cause of district heating and no one more disappointed that circumstances prevented it being applied in the devastated area of the City of London, and, Mr. Forty added, in relation to the cause of clean air, how happy he would be to be present when on October 2nd, 1955, the whole of the City of London would become a smokeless zone, setting an example which it was hoped many other parts of London would follow.

Alderman Russell, on behalf of **Mr. Donkin** and himself, said that, in reply to Dr. Eaton, he did not think it was correct to suggest that as the scheme was based on the results over 20 years, and as at present the scheme was running at a loss, that the present tenants were being subsidized. Surely the position was exactly the same as when new or enlarged gas works were constructed. Presumably they would be constructed with the expectation of an increased future demand. And the works would not be expected to work at maximum economy on the first day they were opened. Nor would the first consumers be charged on the basis of the plant being only partially operative. Perhaps a simpler example might be the first telephone subscriber connected, or the first radio or television set connected.

With regard to the estimated cost of £100 per flat not including the purchase or installation of radiators as these were charged to the cost of the building—there was, of course, an offset of at least the same amount of expenditure in that fireplaces and chimneys were not required to be provided. And in addition there was also a considerable saving of space.

With respect to Dolphin Square, there was not only the saving in fuel and in the emission of products of combustion, but a considerable saving in labour in stoking the boilers, supervision, the delivery of fuel and the removal of ash and clinker. This alone would justify an increase in the cost of an equivalent amount of heat supplied requiring negligible supervision and attention, to say nothing of the saving of the space occupied by the boilers which was made available for other purposes.

As regards the heat consumption, records to date showed that the heat consumption of the average flat at Pimlico approached 700 therms per annum. This increase over the estimated figure of 535 therms per annum was partly explained by the longer hours of heating, and the higher room temperatures maintained. Both of these were found to be necessary to keep the tenants satisfied. But it would be wise to treat the present annual consumption of the average flat as provisional until other data had been accumulated, and a further analysis of the various uses of heat as between space heating, water heating, laundries, heat losses, drying out new buildings, testing new mains and services, etc. had been made.

In regard to the efficiency of the heat supply to Dolphin Square, this was given as 77 per cent. and was derived from an efficiency of 82 per cent. of heat delivered from Battersea from which must be deducted the losses in transmission and distribution to the point of supply at Dolphin Square. Dr. Eaton gave the efficiency of the Dolphin Square boilers as 74.6 per cent. Mr. Donkin suspected that this figure was the optimum of efficiency for continuous running of the boilers, and he would expect that the average efficiency of the type of boiler installed at Dolphin Square, taken over 12 months with skilled stoking, would in fact be found to be not greater than 65 per cent. to 70 per cent. However, even if they accepted Dr. Eaton's figure of 74.6 per cent. efficiency, they could show that because the Pimlico Scheme was a heat electric scheme, they were delivering heat to Dolphin Square which showed a saving in fuel consumption of 15 per cent. compared with what would be used to supply the same quantity of heat from burning solid fuel in the boilers at Dolphin Square.

They were glad that Dr. Eaton referred to the success of the Pimlico Scheme and could confirm that there was no doubt that this was due to its being a heat-electric scheme using low grade fuel in a highly efficient boiler plant.

In reply to Dr. Eaton's last question as to whether such schemes must be of the heat-electric type, there was no hard and fast rule: all aspects of a scheme must be considered before it could be decided whether it would be economic. But clearly if facilities for a heat-electric scheme existed, it was likely to be a potent factor towards making the scheme an economic one.

Dr. Parker had asked how the 11,000 tons saving was to be made. Alderman Russell thought the papers made it clear that this was an estimate of the extra amount of fuel that would be required to provide the standard of heating and hot water supply provided at Pimlico by normal methods. The saving of 3,000 tons per annum was achieved by using the heat-electric scheme as compared with straight central heating by fuel-fired boilers.

Alderman Russell said he was sorry that Mr. Forty felt that less than justice was awarded to the efforts of the City in investigating the possibility of a district heating scheme for the City. Perhaps the remarks might more aptly have been addressed to the Central Electricity Authority, who appear to him to approach the matter primarily as it affected them.

ı the national interest it was so vital to reserve our resources of fuel that any :heme which tended to this end should ave very careful consideration and given very encouragement: even if it meant ɔme inconvenience to the Central lectricity Authority. Rightly or wrongly, e had felt that consideration of the ational as opposed to the sectional iterest had not been accorded the importance it deserved.

If the word apathetic was applied to ie City's effort what was meant to be ɔnveyed was a feeling, perhaps un-'arranted, that there was lacking a urning desire to produce a scheme that 'ould not only be of local benefit, but 'ould also be in the national interest. ınd that the short-term view as opposed ɔ the long-term view was given undue nportance.

J. W. **Moule,** replying, said that the hairman's reference to Mr. Spencer's ecent speech and Dr. Eaton's remarks ıdicated some doubt as to the economics f electrical space heating. Electrical off peak" space heating attracted ɔecially low supply tariffs and, as had een mentioned in the paper, the tenants f the Kirkcaldy flats obtained a full ɔace heating service for £24 and £19 er annum respectively for three-apart-ıent and two-apartment flats, these gures including both the floor warming nd the supplementary heating costs.

Dr. Eaton had referred to certain tests n electrical floor heating, but these were f very limited scope. By far the greatest dvance in this method of heating had ıken place in Scotland and actual results ıowed electrical floor heating to be ɔmpetitive in cost and unsurpassed in roviding adequate warmth. It was on ie strength of actual results that Kirk-ıldy and other housing authorities had ecided to install electrical floor heating ı large blocks of multi-storey dwellings.

Mr. Moule agreed with Dr. Turner ıat the advent of the nuclear generating ation opened up entirely new possi-lities and of all fuels, "off peak" ectricity offered the best prospects of future reductions in price.

Councillor Hewlett had made an extraordinary statement at the end of his remarks, which would shake the widespread belief in the carefulness of the Lancashire housewife. The fact of the matter was that electrical water heating was cheap and with ordinary care would not lead to heavy electrical bills.

Dr. Davidson, replying to the discussion, said he agreed with Dame Vera that most people required full comfort in the living room during occupied periods and short period intermittent heating in the bedrooms. The ducted warm air system, because of its high degree of flexibility would satisfy these requirements. The room thermostat would give the required control of temperature in the living room, while the heating of the bedrooms could be provided as required by opening the warm air registers in those rooms.

Mr. Hazel, Dr. Davidson suggested, was overstating the case for the adaptor type fire in regard to efficiency and flexibility.

Dr. Eaton was correct in suggesting that special care was required in designing warm air installations, but this was true of all heating systems. No high degree of intelligence was required to obtain efficient operation since the control of the system was completely automatic, requiring only the setting of the room thermostat to the desired temperature. The input therms for gas, oil and solid fuel fired warm air systems calculated by Dr. Eaton were correct, the advantage shown by gas being due to the increased flexibility possible with this fuel.

The variation of annual fuel consumption for similar installations was comparatively small, being usually plus or minus 10 cwt. for solid fuel systems. This was because the output was thermostatically controlled, and maximum efficiency was obtained using a wide range of fuels including ordinary bituminous coal. Any variation obtained was due to differences in the comfort standard required by different users.

Local Authorities, the Beaver Report and the Government Clean Air Bill

CONTRIBUTIONS BY LOCAL AUTHORITY REPRESENTATIVES

I

by

Alderman C. H. Smith, O.B.E., D.L., M.R.San.I.

There is a statutory obligation laid upon local authorities to safeguard the health of their residents. They have powers conferred upon them to provide an efficient drainage system, and also to ensure that there is a clean and pure water supply.

Many local authorities now have local legislation to control food handling through shops, restaurants, canteens, schools and all factories concerned in the preparation of food. It is surely natural, therefore, that having powers to deal with the water we drink, and the food that we eat, why should we not deal with the air we breathe, and do our best to see that the air is as pure as possible.

It was in 1661 that John Evelyn laid before King and Parliament his historical indictment against the pollution of the Air of London. By that time coal from Newcastle was being shipped to London in ever-increasing quantities for lime burning, brewing and other like users. The industrial users in due time were to besmirch this land with " those dark satanic mills " against which Blake protested in his immortal poem.

It is now known that most of the local authorities in this country subscribe to supporting the activities of the Smoke Abatement Society and in general approve the Beaver Report. The Authority which I have the honour to represent is in the main a residential area and does not have those problems which fall to the lot of many highly industrialized areas to solve.

For the full benefit to be obtained from the Beaver Report, and from the Act that the Government propose to put upon the Statute Book, will necessitate a complete revolution in the ethics of man's attitude to his neighbour.

When smokeless zones are made a man will be prohibited from polluting the atmosphere in any way which might prejudice both himself and others living in the immediate neighbourhood.

This will naturally necessitate extra cost to the individual, and one must consider how far it is justified to impose such an extra cost. I would say that we are fully justified, as each man living in an urban civilization owes responsibilities towards his neighbours.

In 1855, John Snow published a memorandum on "The Mode of Transmission of Cholera." This is just one hundred years ago and Dr. Snow felt he had discovered how cholera was transmitted, despite the fact that at that time the causative organism was unknown. We are at this stage of evolution in Atmospheric Pollution.

The Beaver Report has been published and accepted by the Government as the guide to future policy, despite the fact that I think members of the Beaver Committee would be the first to recognize that they have not incriminated any particular constituent of polluted air as being the sole agent responsible for causing damage. The Government nevertheless, quite rightly, has indicated its intention to proceed with legislation to prevent atmospheric pollution.

The cost to the individual must be weighed against the benefit to the community in general. Every man must be prepared to expend a little more money on his fuel and heating in order to avoid smoke for the benefit of his neighbours. I would point out that this perhaps means a complete revolution in interior domestic heating in this country.

It is quite difficult to make the open fire smokeless and in a local authority area which is mainly residential this presents a problem. The enclosed stove can achieve smokeless air much more easily, but may well be unpopular, and there will be great inertia to overcome in securing its use.

The convection heater would I am sure enable us to reduce our bronchitis death rate and bring this down somewhere near that of the Scandinavian countries where central heating and heating by enclosed stoves is much more common.

The Government are committed to a Clean Air Policy and we all await the Bill which is to be introduced to the House in the near future.

We feel, as did the Beaver Committee, that the local authorities should be responsible for enforcing clean air legislation within their area—but which authorities? There is no doubt in my mind that those authorities which are sanitary authorities should be the ones selected. There has been a noticeable tendency of recent times to pass responsibilities to the larger authorities, but supervision of clean air legislation should undoubtedly be a function of the sanitary authority.

What officer is to be responsible for supervision in a local area?

The sanitary inspectors under the control of the Medical Officer of Health would appear to be the most appropriate officers to act as clean air inspectorate, but there can be no doubt an additional number of inspectors will be required in many, if not in all areas.

Is the prevention of air pollution to be the responsibility of the sanitary inspector?

Sir Hugh Beaver in his paper "Air Pollution; the problems of Administration" which he read to a recent sessional meeting of the Royal Sanitary Institute, made a statement which read: "There are not very many sanitary inspectors who are able to argue on the level with a trained combustion engineer still less with a process engineer."

The local authority is not concerned that the pollution is from a domestic chimney, or that there was a vertical boiler, no mechanical stoker, bad draught regulation or faulty stoking; it is concerned only with the fact that the atmosphere is shown to be polluted.

It is my opinion that there must be some standard as to what constitutes pollution in each case and some yardstick must be devised and receive statutory recognition.

This would assist sanitary inspectors of a local authority in implementing easily the Act we soon expect to see upon the Statute Book.

Is the local authority to tell those responsible for pollution what step should be taken in order to prevent further pollution? It is not possible at the moment to tell exactly the reason for pollution of the atmosphere

by smoke and attribute the pollution to a specific cause. The possibility is, one factor may be the cause but it is more than likely that there are many contributing to the nuisance.

The responsibility for abating the trouble must rest with the owner of the offending plant. The manufacturers of the many types of boiler plant or fire grates are much more able to educate users than a local government sanitary inspector. Training of stokers up to a certain standard is already in being. I therefore take the view that a local authority must do all it can to get local residents and industrialists to become smoke conscious and realize that clean air is as vital to wellbeing as clean food or pure water.

To assist in carrying out changing plant the Government should allow the whole cost to be against revenue during the year in which the cost was incurred for tax purposes.

Full instructions in all attributes of combustion are readily obtainable from plant manufacturers or the National Industrial Fuel Efficiency Service.

To sum up:

There must be a standard yardstick with which the local inspectors can measure the degree of nuisance—it must be capable of easy interpretation.

The local inspector must receive training of a universal standard to enable him to judge the degree of pollution.

There must be adequate information available to local people to assist them to prevent pollution.

There must be readily available smokeless fuel in quantities adequate to satisfy all consumers, as any campaign for smoke abatement will be doomed to failure if public enthusiasm is whipped up to energetic co-operation and they then find that there is no suitable fuel available.

II

by

Eric Gibbons, A.M.I.G.E., M.Inst.F.

The proposed smoke legislation will give local authorities a long desired opportunity to improve their towns' appearance, amenities and health, at the same time it imposes on local authorities an additional responsibility to take advantage of the new opportunity.

The explanatory memorandum on the proposed Bill sets out four main purposes dealing with the prohibition of dark smoke, the ban on building non-smokeless furnaces, the insistence on efficient grit arresting plants, and the creation of " Smoke Control Areas respectively.

Local Government is made up of permanent officials and elected representatives, and it would appear that the first three main purposes which deal with transport and industrial smoke are likely mainly to concern the permanent local government officers while the fourth main purpose also aims at domestic smoke, and will affect the elected representatives as well.

Local authorities are likely mainly to be concerned with temporary amelioration of smoke on the present railway engines. British Railways, who are responsible for one-seventh of the country's smoke and produce in various tunnels some wonderfully rich fruity concentrations, have published, albeit somewhat tardily, their programme for railway modernization and it would appear that all must wait patiently for the day when a Class 5 is as rare as a Stroudley Terrier is today. This will be a great day for those interested in smoke abatement, even if a sad one for the railway enthusiast.

Industrial smoke, reputed to be

over half the total in the country, has given rise to three evils; firstly by its concentration it has produced the black areas of the country, secondly it has been a shocking waste of fuel—a recent paper having quoted dense black or chart V smoke as wasting 13.5 per cent. of the fuel, thirdly, as long as factory chimneys belch filth into the atmosphere it is hopeless practically and psychologically for the local authorities concerned to tackle the domestic problem. The continuance of the disgusting amount of industrial smoke until the middle of the 20th century can be traced back to the low price paid for coal until World War II with attendant miserable wages for miners and degradation of the mining industry—from which it has not yet recovered, and the parsimonious attitude on depreciation allowance so long adopted by the Treasury.

Industry has reduced smoke since the war, a happy result of the increasing popularity of electric-drives and the necessity to save fuel caused by coal shortage and price advances backed by the progressive policy of Gas and Electricity Boards and by the efforts of firms specializing in fuel economy equipment such as boiler stokers, and it cannot be too strongly emphasized that abolition of industrial smoke is most easily brought about by the use of electricity instead of steam for power, and of city gas, electricity or oil instead of coal for heat treatment processes.

Electricity for power means no warming up or standing of boilers. A steelworks in the author's district, by conversion to electric drive in the rolling mill and the use of waste heat boilers has made redundant a large battery of Lancashire boilers and the boiler stack—once the worst in the district—has been demolished.

For heat treatment, the controllability of gas, electricity and oil means in addition to smoke abatement, more accurate firing with a higher percentage of first class goods, better labour conditions in the factory, and a final fuel saving for the nation. Stoke-on-Trent gives a good example of this, as coal-fired periodic kilns, which used to be pictorially portrayed on "horror comic" post cards as smoke producers, have been, or are being, replaced by gas or electric tunnel kilns, requiring the equivalent at the manufacturing stations of around half the periodic kiln coal requirements, and with that fraction carbonized at the gas works or burnt at the Power Station with little smoke or grit nuisance.

Despite occasional barren threats to move a works out of an area, there is unlikely to be any personal or political difficulties for the elected representatives in supporting their officers' efforts to eliminate industrial smoke. On the contrary, many individual Councillors may claim credit for the disappearance of smoke from what have hitherto been objectionable chimneys.

It is probable that general criticism by local authorities on the proposed new legislation as affecting industry will be levelled at the time allowed for conversion and the transfer of some of the powers to the Alkali Inspectorate.

The time allowance to bring the laggards to heel appears long and one can almost see the " dead hand " of the Treasury frightened by the prospect of an increase in depreciation claims.

The second point that local authorities will question is the wisdom of the transfer of control to the Alkali Inspectorate of not only the nationalized coke oven, gas and electricity industries, which can hardly be queried, but of virtually all industrial firing processes, except steam raising. While all concerned will welcome the technical help that the Alkali Inspectorate can offer in cases of difficulty. many of the industries involved are concentrated in areas where the Local authorities are very alive to their problems, and where any complaints would be, and normally are, dealt with locally without resort to outside help, the latter being under national instead of civic control may be regarded as somewhat distant and impersonal.

Before leaving industrial problems it is hoped that the allowed years will not lapse before office blocks, laundries and especially hospitals, all of which should surely set good examples, put their house in order.

While industrial smoke is likely mainly to concern permanent Local Government Officers, domestic smoke elimination by smoke controlled zones will probably be pressed by the Officers concerned, who will gain kudos for their towns and themselves but will be temporarily a real headache to elected representatives, as although " Smoke Control areas " once adopted should be, and are likely to be, a pleasure to all concerned, especially on washing day, their creation will, like most legislation for the ultimate benefit of mankind, face temporary unpopularity due to residents' fears of:

(*a*) Cost of conversion of their grates;
(*b*) Extra cost of smokeless fuel;
(*c*) Possible shortage of smokeless fuel;
(*d*) The dislike of losing their old coal fire;

To meet these fears, we in the Society know:

(*a*) That under the proposed legislation the Central and Local Government may pay 70 per cent. of the conversion cost.
(*b*) That the greater efficiency of a coke fire largely repays the extra cost per ton spent on the fuel;
(*c*) That the Gas Boards are planning for extra coke production and that more coke is becoming available for domestic use from industries converting to fuel oil firing;
(*d*) That once used to a good coke fire, there will be no more hankering by householders for an old-fashioned coal fire.

The residents' first reaction, however, will be difficult for elected representatives, for the three following reasons:

Firstly, they will have to face an initial barrage of complaint, criticism and abuse from residents frightened of the scheme for one of the reasons already mentioned. The front door bell, while not feared to the extent that is alleged in Dictatorship countries, is nevertheless generally greeted by councillors with a muttered monosyllable; and from the proposed smoke controlled zones many residents will hopefully or despondently appear at their councillors' doors full of grievances and reasons for the abandonment or postponement of the scheme.

Secondly, councillors under our democratic system are elected either:

(*a*) because of their political affiliation;
(*b*) because of personal reputation or popularity;
(*c*) because no-one else in the district is willing to do the work or take the criticism involved.

Having once been elected and unless promoted to the Aldermanic bench, the councillor must face re-election every three years, and if wishing to serve again is frequently in a position by which an unpopular step can halt or finish his civic career.

Thirdly, the holding of the majority of seats by one political party or another is in some towns rightly or wrongly regarded by the parties as of paramount importance, and any procedure which may lose a seat or seats may be ill-viewed by the party bosses, especially in politically marginal towns.

To take advantage of the new legislation, councillors representing a district that may be declared smoke controlled, must be prepared to face temporary unpopularity, and their political party the possible loss of seat or seats, knowing that by their action they will have conferred to the district, the town, the residents and their successors, advantages in cleanliness and health long denied them and that posterity anyway, will applaud their action.

Local Authorities have been the backbone of this Society and have expressed their support of " Smoke Control Areas ". Now, as they say in Missouri, " They can show it."

III

by

J. Graham, F.S.I.A., M.R.S.I.

Chief Sanitary Inspector, Manchester

At present in any discussion on Air Pollution recognition is bound to be given to so much having been reported on the subject that the dominant need s the effective translation of words nto action. In considering action to be taken, however, whilst guarding against platitudes, doubtless it will also be recognized that measures to be urged shall neither fall short of obligations to society nor fail by attempting to exceed the prevailing bounds of practicability which stimuated research must expand.

The Beaver Committee's Report presents a comprehensive statement on he whole problem with directions oward practical solutions and, irrepective of the frustrating issue of ulphur dioxide pollution or the question as to who shall be responsible or the control of " scheduled proesses," effective implementation of he Committee's recommendations learly would be a major step to the leaner air so long sought.

Experience demonstrates, however, hat the determination and effort equired to establish and implement a lean air policy on an effective scale annot yet be assumed to be generally ecognized. Certainly the need has not been a national conviction and whilst public opinion has become more moke conscious, it does not follow hat there is a general appreciation of what is entailed, or given the knowedge, determination to apply it. In he minds of too many " smoke preention " is still synonymous with the prevention of only industrial smoke and their appreciation of the problem s correspondingly limited. Given the vailability of alternative solid fuels and the provision of suitable approved domestic fire grates, to what extent has there been a voluntary relinquishment of the use of bituminous coal? How many housing authorities having provided the suitable approved fire grates designed to burn coke, have chosen to lead their tenants further by requiring them to use only smokeless solid fuel in these grates? How many local authorities have consistently supported their officers diligently to apply existing law to deal with industrial smoke nuisances in spite of all its weaknesses? How strenuously have local authorities sought amendment of that law and how much encouragement have they received from successive governments in the past? What has been the experience of those local authorities who sought confirmation of smoke byelaws? When court proceedings have been taken how seriously have some lay magistrates regarded smoke nuisances?

The answers to these and many similar questions are well known and with notable exceptions evince that the achievement of the objective of the reduction of smoke in all heavily populated areas by 80 per cent. within 10 to 15 years, as expressed by the Beaver Committee, calls for infinitely greater determination than has yet been practised. The fundamental need is a sincere change of attitude by the individual both as an industrialist and as a householder and to secure that change a vigorous lead to be taken by central and local authorities through persuasive and coercise measures.

Persuasive measures

It would be wishful thinking to anticipate that only publicity as to the objective, benefits, means available,

personal implications and progress or lack of it, will stimulate the individual consumer of fuel to make the effort required. Enlightened self-interest has and continues to make its voluntary contribution, but the general scale of that effort in relation to the national need is meagre. The avenues of communication with the public through the Press, sound and vision broadcasting, exhibitions and so on have long been used and certainly local authorities who have been active in smoke prevention can pay tribute to balanced reports and commentaries by the more progressive of the national, provincial and technical press. In addition, the television documentary feature early in 1953 with its evocative questions to the individual viewer was invaluable at the time. Unfortunately, however, the impact of the information so conveyed is transitory and experience clearly demonstrates that public knowledge of the problem and means toward its solution is not enough to bring about the necessary changes in habits.

This experience does not mean that publicity should be neglected; on the contrary, every available means should be used with " vigour and convincing presentation." Correspondingly, there is a need for emphasis to be placed on the personal contact with the individual to ensure a correct technical and tactful approach to each person.

The value of such information and consumer services as those of the Gas Council, Coal Utilisation Council and Central Electricity Authority toward clean air is unquestionable. But the success of their efforts is subject to an inherent limitation of being concerned basically with the sale as distinct from the use of appliances.

The householder may purchase a recommended solid fuel appliance capable of burning coke but not choose to burn other than coal which, although thereby accomplished with some increased efficiency and less smoke, does not achieve the objective of clean air. Similarly, apart from the possibility of a requirement in a tenancy agreement, the occupiers of municipal houses provided with such grates may choose not to burn smokeless fuel. In either case, of course, the presence of the suitable appliances greatly aids the ultimate inclusion of the houses in a " smokeless zone " or " smoke control area." But to facilitate the abandonment of bituminous coal for smokeless fuel, which in general means gas coke, the personal link between the householder and the enforcing authority is invaluable. This is especially evident when regard is had to the need to overcome prejudice against the use of gas coke both in respect of price and suitability. The publicity of the sales and information services referred to is essential. But it does not remove the need for a technically and tactfully competent more personal approach to the individual whose freedom of choice is to be restricted both in his own and the public interest.

Clearly the success of the establishment and extension of the central smokeless zones in Manchester (Fig. I) owes no little to the value of the sanitary inspectors' or smoke abatement officers' interviews with each occupier. This personal contact by a local authority's officer, who directly, at least, was not selling any fuel or appliance, anticipated difficulties, crystallized solutions and identified the City Council's policy with individuals by individuals. It stimulated an essentially human relationship whilst also providing the necessary more mundane data for the assessment of requirements especially in terms of alternative fuels and subsequent assurances as to their availability for the estimated demand. Necessarily these officers so responsible for the making of the survey and the handling of the many enquiries have to be technically competent and tactful, both of which attributes have long been recognized as essential to the effective carrying out of their related duties in environmental sanitation, with emphasis on securing rather than enforcing compliance.

Reverting to overcoming prejudice against the domestic use of coke, it

Fig. 1.

has to be recognized that coke cannot be burned satisfactorily or economically in the old open fire grates or ranges such as the Yorkshire range (Fig. II) of the 19th century and earlier part of this century. Further, in the suitable approved modern domestic grate coke does require more attention than coal if it is to give satisfaction. Indeed it will be recollected that the Beaver Committee found that much of the coke available would not burn satisfactorily on these grates, but fortunately for the future of the clean air policy this failure does not apply to coke produced from all retorts.

Fig. 2.

Clearly, in considering the availability and suitability of smokeless solid fuels, due regard must be paid to the type of domestic appliance in which they are intended to be used. With an open fire, ease of ignition and rapid recovery when replenished, even from a low fire may be an essential requirement. An openable stove on the other hand, because of its accurate control of combustion air, may not require such conditions. With this, coke of a higher density may be more important so as to secure the inherent advantages of this appliance in running for long periods without attention. It is recognized that the less reactive cokes, although they are more difficult to ignite, once burning properly, emit a higher proportion of heat by radiation than those fuels which are more combustible. Thus in the case of the open fire which is required to heat mainly by radiation, it will be seen that the demand for certain properties in this fuel such as ease of combustibility concurrent with high radiation may be incompatible.

Similarly in regard to relative prices of gas coke and coal there appears to be a danger of making unrealistic demands of the gas industry. Thus in a recent discussion on the Beaver Report, the London price of gasworks coal, pre-war was quoted as having been about 19s. 6d. a ton, and domestic coal 50s. a ton. By 1955, coal at the gasworks cost 90s. a ton and domestic coal 130s. a ton and it was pointed out that if domestic coal had increased in price in the same proportion as gas coke, the domestic consumer would now be paying £11 10s. a ton. The conclusion was that the domestic user of raw coal had been given a bonus of £5 a ton! At a more domestic level it is important to ensure regular frequent deliveries of coke to households whilst the need for proper storage should be recognized; not in the open to become rain soaked. Further the householder should appreciate that it does require greater attention than coal for satisfactory burning, e.g. greater depth of fire and generally more careful attention.

The experience of Bradford and Nottingham, with their post-war condition of tenancy requiring the use of smokeless fuels proceeding logically to the establishment of smokeless zones, demonstrates the practicability of burning coke in the suitably designed modern grate. In the absence of these appliances, however, any assessment of the task of dealing with the vast numbers of old fire grates or ranges in the " black areas "

emphasizes the practical approach and belief of the Beaver Committee that for any real advance to be made in abolishing smoke from domestic chimneys there must be a combination of "compulsion to stop producing smoke with financial help in providing the means to do so."

It is gratifying that the Clean Air Bill accepts this essential principle in its proposals including grants toward the cost of converting domestic appliances in smoke control areas. In implementing this, however, local authorities in "black areas" will have to contend with a dilemma arising from these black areas coinciding with the heaviest incidence of unfit houses; houses overdue for demolition but in many districts, at the present rate of rehousing, too numerous to be cleared within the contemplated 10 to 15 years target period of the "clean air" policy.

Those local authorities have estimated the total number of unfit houses in their districts and prepared their first five-year programme of demolitions and retentions for patching to a standard "adequate for the time being." Now, however, if the clean air policy is to operate on an effective scale in the areas where it is most needed what shall be done with the obsolescent coal burning ranges and grates in the unfit houses which cannot be demolished for many years? At present the burnability of coke in those old appliances does not offer the use of that fuel as a practical proposition and the prevailing cost of low temperature carbonization fuel in terms of cash precludes its compulsory use in those households. Hence, even in unfit houses, unless due for demolition within the target period for reali ation of the clean air policy, if the problem is to be faced squarely replacement of obsolescent grates and ranges burning coal, by modern grates burning coke, and the accompanying structural work seems unavoidable.

In the industrial field there have been numerous pronouncements on the need to utilize fuel efficiently and as expressed in the British Productivity Council's report of September, 1953, "by and large British industry has not replaced or materially modified its fuel and power equipment since the first world war; it is old and inefficient." That report further recognized the unlikelihood of industry changing its habits "unless it is actively assisted, persuaded or even coerced to do so by legislative means." Perhaps the recent increase in the price of coal will provide the necessary incentive towards its efficient use or greater replacement by oil and happily coincide with less smoke, but the experience of smoke abatement workers affirms the need for the added stimulus of legislative coercion. The combined operation of local authorities aided by more stringent legal sanctions, the National Industrial Fuel Efficiency Service and possibly the availability of the Government Loans must prevail where enlightened self interest has proved of little avail in securing clean air.

There is a tendency, however, to regard the problem as exclusively one of capital and plant replacement and it is salutary that the Beaver Committee also focus attention on the technical skill of an operative being as valuable to industry as the technical efficiency of the plant and apparatus he is required to operate. Certainly he should receive the wage his skill deserves and should be encouraged by financial inducements to equip himself most effectively by attendance on courses such as those of the City and Guilds of London Institute.

Some fuel conscious industrialists do recognize this, but generally there is little inducement for stokers to attend stokers' classes. A notable exception exists in Manchester where one of the largest firms working three shifts, pay class fees, allow afternoon shift workers to finish in time to attend the class without loss of pay, whilst night shift workers commencing earlier receive overtime rates of pay for doing so and finally a bonus is paid over the

ordinary rate per hour to those who obtain the Boiler Operators Certificate. Manchester Corporation recognizing the value of precept and example in demanding a clean air and efficiency also operate such a scheme for any of their personnel engaged in the firing or maintenance of boiler plant. Before presuming to criticize the absence from the Beaver Report of a recommendation as to compulsory certification of stokers, should we not first set the example of adopting a voluntary scheme of inducement? Clearly there is nothing altruistic in these schemes: they are essentially good business, especially when it is found, as in Manchester, that the principal cause of excessive smoke emissions is still bad firing.

Coercive measures

Members and officers of local authorities have long recognized the deficiencies in the existing law as expressed in the Beaver Committee's report and the Government's Clean Air Bill, which closely follows the purport of the report, has been awaited with uncommon interest.

It presents the first comprehensive measure to deal with smoke prevention and its thorough approach, especially in the logic of bringing domestic smoke with financial inducement into the scope of national legislation, is to be welcomed. This does not mean, however, that the need for a critical examination of its provisions, especially details as drafted, does not arise. Certainly it is regrettable that in drafting legislation to embody a standing principle, in this case the policy of clean air, so much attention seems to have to be given to accommodating the intricacies of individual situations and different contingencies as to create a risk of stimulating preoccupation with exemptions, reservations or safeguards rather than observance of the principle. This risk is illustrated in respect of the defences available on the emission of dark smoke under Clause 1 of the Bill, temporary exemptions under Clause 2 and the possible exemptions in smoke control areas under Clause 8.

Perhaps the universal application of law as distinct from the implementation of a *local* Act precludes leaving particular contingencies to the good sense and discretion of every local authority and its officers. Nevertheless, in formulating exemptions, experience should clearly demonstrate that they are necessary to prevent unreasonable application of the law. In this respect the desirability of stipulating all the wide defences in the clauses mentioned seems questionable. This is particularly shown in comparison with the existing law relating to emissions of black smoke, in regard to which the defence of " best practicable means " is at present not available, but in effect would be restored by the proposed defences in clause 1 (3).

Smoke abatement workers will welcome the meaning given to dark smoke, especially having regard to the terms of the later provision in the Bill which also enables smoke other than dark smoke to be dealt with as a nuisance. Assessment of the full value of this definition, however, will have to await the form of regulation the Minister may prescribe in dealing with the time standard, which, no doubt, will follow the recommendation of the Beaver Committee. In that event the length of time during which an observation may have to extend before the permitted maximum of 6 minutes of dark smoke is exceeded may prove to be of some embarrassment to the effective carrying out of the duty by the officers concerned. Thus after the lapse of 4 hours the prospect of being able accurately to determine the precise circumstances responsible for emissions, more especially the cause of the earliest emission, may be very dubious. Another possibility is the length of the observation extending into hours of darkness to preclude its actual completion. These points, however, should not be over-stressed or interpreted as being critical of the suggested time criteria; certainly the opportunity of applying such an improved standard should be taken

without hesitation and without anticipating undue difficulty in their operation.

The Bill's use of the term "building" in relation to smoke emissions imposes an undesirable limitation arising from the fact that smoke may be emitted from other than a building, e.g. an industrial furnace may be installed outside a building. In this latter event the provisions of Clause 1 relating to prohibition of dark smoke from chimneys would not be applicable: similarly in respect of smoke control areas the emission of smoke other than from a chimney of a building would not be actionable, further, in the abatement of smoke nuisances under Clause 12, such as from the burning of trade waste on land, the same inability to proceed would occur.

Manchester's experience in the operation of the Manchester Corporation Act, 1946, Section 36, which deals with the prevention of smoke from industrial furnaces and originally referred to a " building," was such that the opportunity was taken in the Manchester Corporation Act, 1950, to secure the addition of the words " or on any premises," " premises " having the same meaning as in the Public Health Act, 1936, and it is suggested that an amendment to the drafting of the Clean Air Bill is warranted to remove an otherwise unnecessary restriction contained in the words " a chimney of any building," Thus in Clause 1 this would be achieved by the deletion of the latter words and the substitution of " any premises."

Clause 3 dealing with the smoke from furnaces re-enacts part of the standard form of the clause used in local acts dealing with the prior approval of installations. But neither the existing local provisions nor the proposals now made meet the following points which have been urged by some local authorities.

Firstly, that any installation should not only be capable of being operated continuously as far as practicable without emitting smoke: also it should be so operated. The logic of this additional condition is recognised in Clauses 4 and 5 in respect of the prevention of grit and dust from furnaces but is absent from Clause 4 dealing with smoke. Thus in the latter case it can be submitted that so long as the installation is capable of being operated as intended and is " burning fuel of a type for which the furnace was designed," the emission of smoke is not an offence.

The second point with which some local authorities have been concerned is the controversial one of making the form of prior approval of a compulsory instead of a permissive nature. At least it is suggested that there is a case for prior notification of intention to install if not approval of the installation so that a measure of advice then may be offered by the officials who will subsequently be responsible for securing compliance with the Clean Air Act. An illustration of the value of such advice at the onset is available in respect of the use of mechanical stoking. The reiteration of the term " smokeless " has led some non-technical and indeed other managements to believe that the introduction of any form of mechanical firing will secure smokeless operation. Clearly, whilst particular conditions may be such that a certain type of mechanical firing under proper supervision with suitable fuel could result in substantial smokelessness, operating conditions are not universally uniform and there are numerous factors which must be considered to ensure that new or existing plant may operate not necessarily smokelessly but certainly to comply with the recommended new density standards. A non-technical management may be at a loss to determine what appliance may be used to meet its specific needs and smoke abatement workers are aware of some rather specious claims that all troubles are overcome if only a certain appliance is installed.

Concerning the general issue of prior approval, there is a notable difference between the permissive nature of the clause in the Clean Air Bill and the annual registration with, in effect,

the strict form of compulsory prior approval to which the scheduled and certain other processes would become subject on transfer to central control under the Alkali Act: consistency alone would provide for at least compulsory notification to local authorities on the installation of other plant in respect of smoke emission. A further point warranting consideration in relation to prior approval, irrespective of its obligatory or permissive nature, is that of proper instrumentation of the plant.

Whilst the prevention of smoke emission from furnaces does not necessarily depend entirely on the provision of such instruments as draught gauges, CO_2 recorders, feed-water meters, pyrometers, smoke alarms or recorders, their value in that regard, coupled with securing the efficient use of fuel, is self-evident and fully recognized by efficient managements. It has to be admitted, however, that none is an integral part of a " furnace " in the accepted sense of the word and to that extent it does not seem that in considering any plans or specifications under Clause 3 (2) a local authority could do more than commend the use of some or all of these aids to both efficiency and smoke prevention. Surely, the need to command fuel economy and smoke prevention is such that the opportunity should be taken to embody a suitable clause in the Bill requiring a modicum of instrumentation at least to plant above a certain rating.

The Beaver Committee recommended " smokeless zones," as provided for in local Acts, and the innovation of " smoke control areas " in which the domestic consumption of coal containing more than 20 per cent. of volatile matter would be prohibited. The Bill deals only with " smoke control areas " and presents a formidable list of possible exemptions to the prohibition of smoke in such areas.

However, as Clause 8 does express the prohibition of smoke, it might be considered to provide for a more rigorous standard of a " smoke control area " than that of the Beaver Committee where the emphasis would be on the direct control of the fuel used. But to some authorities the prohibition of smoke will seem to be defeated by the possible reservations as to its application, more especially in the absence of a qualification as to the manner in which the fuel shall be burned so long as it is authori ed fuel. Thus it might be stressed that with domestic smoke " it is the cumulative effect of light smoke from a large number of low chimneys that matters," and that the formal recognition of domestic smoke emission is inconsistent with the objective of a clean air policy. This attitude, however, would raise the target from 80 per cent. reduction in smoke in all heavily populated areas, without recognizing that, although seemingly anomalous, smoke does arise from " smokeless " fuels other than gas and electricity and acceptance of that fact is realistic. Nevertheless, it should not be denied that there should be safeguards against abuse of any exemptions. Thus the validity of the defence in sub-clause (2) should also depend on proof of proper use of the fuel, e.g. everyone is aware of serious smoke emission that can arise from the faulty combustion of oil. Similarly any exemption of a fireplace, presumably having regard to the possibility of a successful outcome in the future of work such as that of B.C.U.R.A., should ensure not only that the fireplace could be used without " producing undue smoke " but also require that it was so used.

Concerning the grants for the conversion of domestic appliances in smoke control areas, there is a welcome logic in the recognition of the need for financial inducement for this purpose. It does seem, however, that provision whereby consent of the local authority to the removal of an appliance which had been the subject of a grant, even after the two years period mentioned in the clause, should be included. It is recognized that no further grant would be available in respect of the house, but it would be helpful to minimizing the risk of subsidi ing a trade in portable or free standing

appliances from smoke control areas if some such condition was attached to the grant.

On the abatement of smoke nuisances, Clause 12 is intended to provide a necessary supplement to the control of smoke not otherwise actionable under the Bill. Unfortunately, however, as drafted it would seem to leave local authorities with the cumbersome, out-moded procedure of Part III of the Public Health Act, 1936, with its prolonged method of service and expiration of abatement notices and application to the Court for Nuisance Orders. This would be inconsistent with the general recognition of the need for prompt summary power to deal with such nuisances and logically requires amendment to provide that remedy.

Clause 13 in dealing with special cases presents a controversial issue in the contemplated transfer of responsibility for the control of the " scheduled processes " and certain others in its deviation from the principle of local authorities being responsible for the prevention or control of smoke emission. This, of course, follows the report of the Beaver Committee who considered that the smoke from the scheduled processes and certain others presented special technical difficulties which, at present, unlike the emission of smoke from other sources, were not amenable to the application of defined standards. Accordingly, they would be dealt with by the Alkali Works, etc. Inspectorate until such standards could be applied when the control would revert to local authorities. It is important, however, also to note that the Committee emphasized the need " for vigorous and continuous action to secure the development of satisfactory preventive measures in all these cases." In this regard no doubt the Clean Air Council commended by the Committee could serve a most useful purpose in vigilance to stimulate such action.

The proposed transfer understandably is a matter of concern to smoke conscious active local authorities who are sensitive to the need for radical changes in some existing practices in those scheduled processes, but are sceptical of such being secured by what they consider to be inherently sporadic central, as distinct from continuous, local control. The history of apathy in respect of the iron and steel industry with the prolonged provisional exemptions of questionable justification in the light of technological knowledge has not encouraged confidence in the proposal. The compromise which was provided in the Bill of Mr. Gerald Nabarro, M.P., whereby local authorities who satisfied the Minister that they possessed the necessary resources and technical staff would retain the responsibility for the special processes, recognized that a universal technical incapacity of local authorities to cope with such processes could not be sustained as a reason for the change. But it has to be admitted that the compromise would introduce an undesirable dual responsibility. Certainly, if the proposal is implemented, the existing establishment of seven district Alkali, etc. Works Inspectors will have to be greatly expanded to meet the technical difficulties and increased responsibilities; an expansion which is in any event overdue to cope with the chemical engineering industry in the country.

The Bill does recognize that technical difficulties advanced as a reason for the proposed transfer, justifiably cannot be applied to a works simply because it happens to be registrable under the Alkali Act. The technology of combustion for example in steam raising at a cotton mill or other factory is the same as at a sulphuric acid or other chemical works and either type may emit dark smoke or create a smoke nuisance which at present is actionable entirely by the local authority. Clause 13 (1) recognizes that the local authority may continue to be so responsible dependent on the source of the smoke emission in relation to the actual registrable process; otherwise proceedings would require the consent of the Minister. It is important to note that under sub-clause (4) the

consent would not be required in respect of dark smoke or smoke nuisance from work not directly concerned in the processes which necessitate its registration under the Alkali Act and the full significance of the reservation as to proceedings would seem to depend on the interpretation of sub-clause (4); i.e. whether there is a direct connection between the smoke emission and the particular processes which necessitate registration of the premises under the Alkali Act.

As recommended by the Beaver Committee and accepted by the Transport Commission the not too long-term solution to the smoke from the railways is that of a programme of electrification. In the meantime, the Bill logically recognizes the need for minimizing the emission of railway smoke so far as may be practicable and abandons the prevailing available obsolescent procedure of action by a common informer. The general value of the provision, however, is inevitably limited, having regard to the inherent nature of coal-fired locomotives, the defence of practicable means, and the impracticability of dealing with other than a stationary engine. This should not mean that people unfortunate enough to live in the vicinity of locomotive sheds should have to await electrification for relief from the smoke palls with which they are commonly inflicted.

Whilst the Bill provides for Parts I and XII of the Public Health Act, 1936, generally to be applicable, two particular points require removal of doubt in relation to the enforcement of the Bill's provisions. The power to enter premises conveyed by Section 287 of the Public Health Act, 1936, is made available for the purposes of the Bill but so far as dwelling houses are concerned it is not to apply except in relation to entry as to work on the adaptation of fireplaces under clause 9 (2). This limitation seems to overlook entry to dwelling-houses being required for other provisions in the Bill. The further point relates to circumstances where the cause of dark smoke emission arises outside the area of a particular local authority but the smoke is clearly affecting that immediately adjacent area. At present Section 98 of the Public Health Act, 1936, provides power to the adjacent local authority to proceed against the responsible person and whilst no doubt this action would continue to be available in respect of smoke nuisances under clause 12 of the Bill, it is desirable and logical that it should also be applicable in regard to dark smoke or grit from furnaces outside the district.

Administration by Local Authorities

The more controversial issue of the scheduled processes has been referred to earlier and, except for a reservation in that regard, local authorities will continue to be responsible for a service of national importance but of special local concern. Further, the importance of "joint action or other arrangements to secure effective co-ordination" in the large urban and industrial centres should continue to be recognized by local authorities in their membership and support of regional advisory committees.

Irrespective of the particular form of organization adopted, however, it is evident that the achievement of effective action will entail the exercise of increased responsibilities by local authorities to secure or enforce smoke prevention. Fortunately for the prospects of success this will not require the creation of an entirely new body of officials. The duties will be new in their emphasis and a determination by all local authorities rigorously to fulfil the responsibilities and all that entails may also be new. But the technique to attain the fundamental objective of smoke prevention is already a function of the local authority's sanitary inspector either in the course of his normal duties or more especially in industrial areas his special duties as a whole-time smoke inspector.

It is not within the range of these observations to discuss the appropriate geographical, functional or mixed

organization of that officer's duties with a local authority. Clearly, however, the vital factors are not necessarily full or part-time assignment to smoke abatement but the nature of the qualifications and experience of the responsible officers, the relevance of other duties and the numerical adequacy in staff. Whilst the basic qualification of a sanitary inspector does have regard to smoke abatement, the need for increased attention to the subject has long been recognized and was recommended by the Minister of Health's Working Party under the chairmanship of Sir John Maude. Doubtless the recommendation will be implemented in the pending reorientation of the scheme of the training of that officer together with improvement of the existing supplementary qualification available for those who wish to specialize in the subject. The relevance of their other duties previously has been referred to in persuasive measures with especial regard to housing and domestic smoke and the significance of tactful competency long required of those officers cannot be overstressed in the new emphasis to be placed on securing clean air.

The numerical adequacy presents a problem the solution of which is a test of the degree of conviction especially of local authorities, on the need for an efficient service in environmental hygiene in general and clean air in particular. It will be recollected that the Working Party's investigation found that 423 sanitary inspectors possessed the additional certificate in smoke inspection, of whom 308 were employed in boroughs. It was also found, however, that in many cases areas were understaffed and whilst the effect of this was not specifically related to smoke abatement there is no doubt as to its significance to those duties, especially as the incidence of shortage and failure to recruit to the service was and remains greatest in the " black areas." The several factors involved in the solution, clearly expressed in the Maude Report, are virtually within the discretion of local authorities and if the " locality " in " local " government is to be meaningful the significance of these factors ultimately must be accepted.

Perhaps on more technical issues the commendation of the Committee on annual reports from local authorities to the Minister, though not accepted in the Clean Air Bill, and the formation of a Clean Air Council annually reporting to Parliament clearly recognize the need to ensure the closest of relations between intentions and achievements at all levels. They certainly identify accountability with responsibility and are important safeguards against a risk of apathy in sustaining efforts required to achieve the target of a clean air.

Conclusion

In conclusion it may be submitted that the primary task of these discussions apart from any assessment of the Clean Air Bill may be far more to clear away the blind prejudices which prevent men from seeing the air as they have polluted it than to offer technical means to the end of that pollution. Essentially the doctrine has to be propounded that there must not be subordination of the end to the means, the limitations of which must present an opportunity and a constant challenge to their own removal. The report of the Beaver Committee has clearly postulated a Clean Air Policy as a fundamental need for the welfare of the country. It remains for the goodwill of every individual to ensure that the need is satisfied and for the Government and local authorities to stimulate the goodwill by persuasion or, in the ultimate, coercion.

IV

by

John Douglas, M.D., D.P.H.

Medical Officer of Health, Bradford

This paper describes the method adopted in Bradford to deal with the problem of domestic smoke in post war housing estates, and discusses the usefulness of a procedure which is recommended by the Beaver Committee.

The City of Bradford has a population of 288,400 and covers an area of over 25,000 acres situated in a bowl-shaped depression on the eastern side of the Pennines. Much of the land within the boundaries is useless for building purposes with the result that both industry and dwellings are concentrated for the most part in the centre of the bowl. It is the centre of the wool trade and most of its 338 industrial chimneys are those of wool mills. Of the 94,983 dwellings in the city 9,541 were erected by the City Council before the last war and 5,771 since then. The remainder—79,671—are privately owned dwellings.

In the early months of the post war period the Health Committee gave a great deal of consideration to the problem of atmospheric pollution, and being aware of the practical impossibility of effecting improvement under existing legislation during a time of continuing fuel shortage determined to seek powers, as recommended by the National Smoke Abatement Society, to establish smokeless zones. These powers, together with those for District Heating, were duly obtained in the Bradford Corporation Act, 1949. It was appreciated that some years would elapse before such powers, if obtained, could become effective and that an alternative approach was necessary if any immediate progress were to be made.

In the past all efforts at smoke abatement had been concentrated on the factory. Dr. Hime, Medical Officer of Health of the City in 1884 comments in his annual report for that year as follows: " The existence of a black pall of smoke over the town is quite unnecessary to the trade of Bradford. As a matter of fact it represents a permanent leakage in profits of a very considerable amount. The visible cloud of smoke which hangs over the town is unburnt fuel. The extent to which the atmosphere is polluted with smoke is highly depressing in its effects. The exhilarating effect of a short escape into a bright clear atmosphere is a familiar subject for remarks. Sunlight is essential to the vigorous life of both plants and animals and where the atmospheric conditions are such as to render plant life precarious, as in Bradford, men and animals must also suffer. As the existence of the unnatural and unhealthy conditions of the atmosphere produced by smoke-manufacturers is highly prejudicial, it is to be hoped that united action will be taken by those who are wantonly and unnecessarily injured by it to protect themselves."

The castigation of the " smoke manufacturers " of 1884 was probably justified, but not so today—the industrialists in Bradford, with few exceptions, have co-operated most willingly with the local authority and, although there still remains an immense amount of work to be done, over the years there has in fact been a gradual but noticeable lessening of the smoke nuisance. The graph (Fig. 1), shows this quite clearly. It is probably true to say that the main contribution to this improvement has been

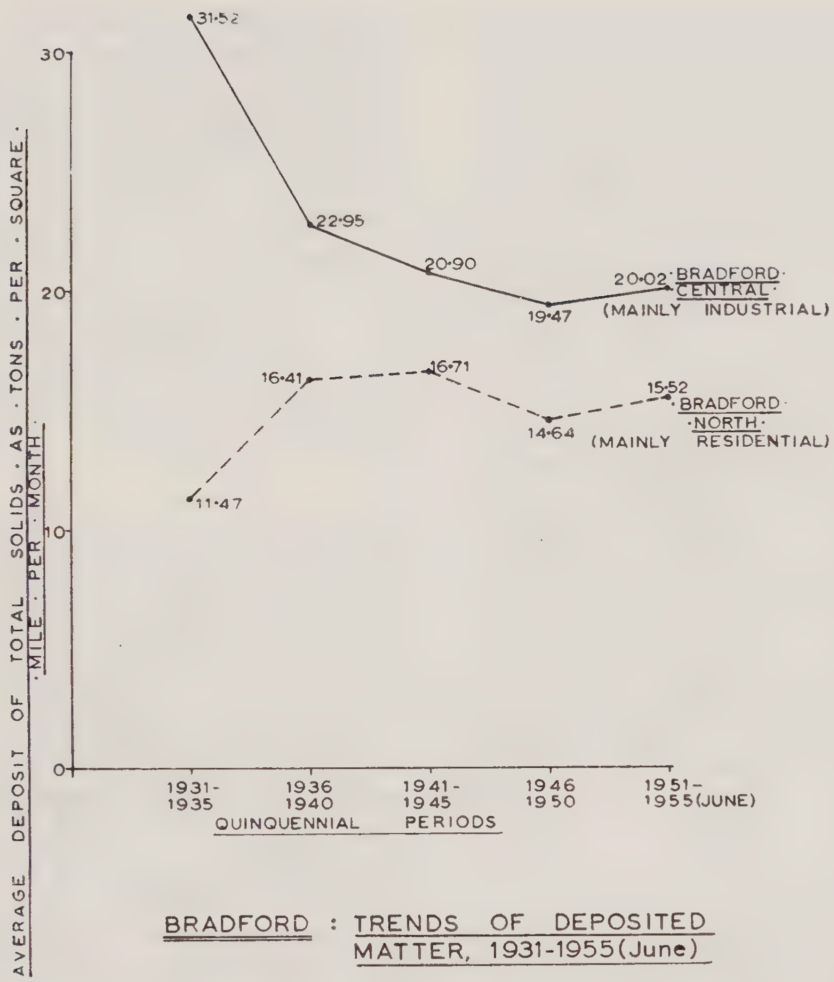


Fig. 1

made by industry and commerce and that the part played so far by the householder has been comparatively negligible despite the increased use of gas and electricity and improved solid fuel burning appliances in the home, which must have had some slight effect.

It should be mentioned that at the time when these matters were under consideration the responsibility for planning the post-war housing programme was also the concern of the Health Committee, and this greatly facilitated the subsequent development of the Corporation's policy on smoke abatement. The need for fuel conservation during the war and the studies to this end made by the Egerton Committee on the Heating and Ventilation of Dwellings had focused attention on the very significant part played by the domestic fire in dissipating the national fuel resources and thus adding to the smoke pall over our cities. The Health Committee in its consideration of this timely and most valuable report were not unaware that they themselves during the inter-war period in their enthusiastic drive for slum clearance had in fact erected some 10,000 municipal houses which it was now estimated were responsible for over ten per cent. of the smoke derived from domestic sources. This was a disconcerting thought to the Public Health Committee and they determined that such a happening should not be allowed to recur. Some method had to be sought to prevent the emission of smoke from the chimneys of the new housing estates.

In March, 1946 came the findings of the Simon Committee on Domestic Fuel Policy and when the Government accepted its recommendation "That in subsidised houses the Government should make use of

approved solid fuel appliances a condition of subsidy," the Bradford Health Committee unhesitatingly took what they conceived to be the next logical step and decided to minimi e the smoke on the new housing estates by requiring the occupiers, as a condition of tenancy, to use only smokeless fuels in the appliances provided; this policy recommended by the Beaver Committee in 1954 was put into operation in Bradford in 1946.

The best policy to pursue in districts outside the black areas is difficult to determine because of the cost involved in conversion of grates in pre-war houses, a problem not arising in the case of the post-war house. Much will depend on the progressiveness of the authority concerned and the speed with which solid smokeless fuels can be made available and thus allow of the development of Smoke Control Areas in such districts.

Privately Owned Houses

The private house is the main source of domestic smoke. Such houses, 79,671 at the present time, constitute 84 per cent. of all the houses in Bradford, and of these roughly one-third are of back-to-back construction. The slum clearance programme for the next 20 years envisages the demolition of over 11,000 existing private houses, most of them of the back-to-back type.

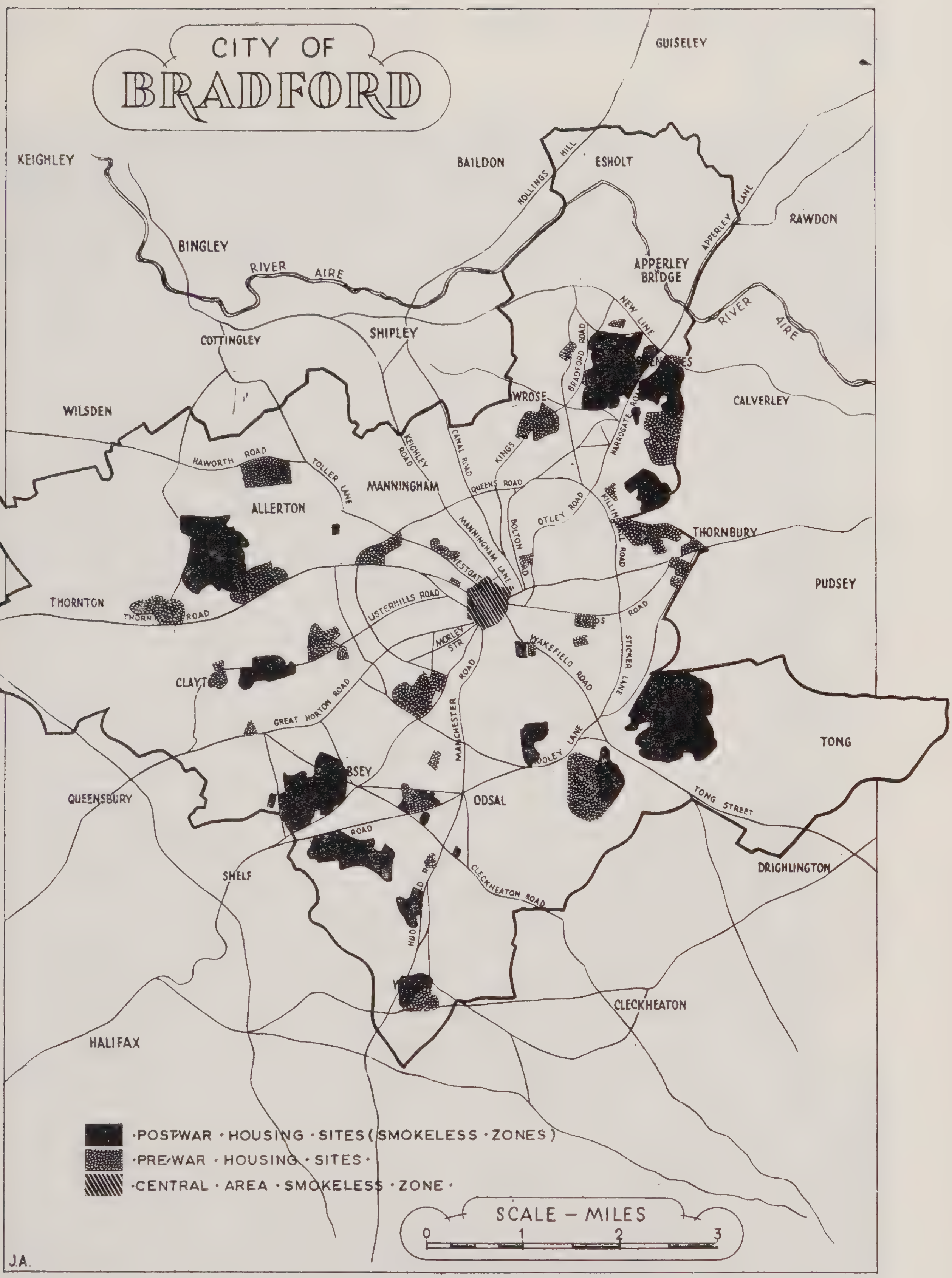
Cities and towns afflicted with large numbers of back-to-back houses have the smoke problem aggravated by the high density of such properties. Moreover these houses are usually built without gardens and abut directly on the public footpaths of narrow streets so that there is an inadequacy of space about the buildings to allow of speedy dissemination of smoke. Local authorities' proposals for slum clearance are now defined for the next 20 years and it is a temptation to omit such houses from smoke control area proposals. This temptation must be resisted particularly in the case of the back-to-back house, and I would suggest that only those in the first five years of the programme should be excluded. Much will, however, depend on the speed with which authorities implement their Smoke Control Orders and overcome the physical difficulty of converting large numbers of obsolete fittings.

There can be little criticism of the straightforward approach in the Clean Air Bill to the domestic smoke problem. The financial provisions are most welcome, and provide stimulus and encouragement to local authorities and minimi e possible objections from the private citizen.

Pre-War Houses—Operation of Tenancy Agreement Clause

The relevant clause inserted in the tenancy agreement reads " the tenant shall not burn in any fireplace designed for the burning of smokeless fuel any fuel other than smokeless fuel unless it can be shown to the satisfaction of the Corporation that such fuel is unobtainable in the district in which the premises are situate." It was realized that this provision would break down if in fact the supply of smokeless fuels did not keep pace with the growth of the housing estates. To obviate this the closest liaison was established, and has since been maintained, with the North Eastern Gas Board, the major producers of coke in our area, and I would pay tribute to them in that they have never failed to maintain supplies, even in times of acute fuel shortage. Thus at no time has any tenant had occasion to invoke the escape clause.

It would be quite wrong to give the impression that the burning of smokeless fuel was accepted with eagerness by all tenants. The post-war shortage of housing accommodation was such, however, that applicants were not in a position to refuse the offer of a house with this condition of tenancy attached. Quite frankly the Corporation made use of the housing shortage to further the cause of smoke abatement with the result that there is now quite a considerable section of the population accustomed to the use of smokeless fuel. Consciously or unconsciously, willingly or unwillingly,


CITY OF
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GUISELEY
KEIGHLEY
BAILDON
HOLLINGS HILL
ESHOLT
RAWDON
APPERLEY LANE
BINGLEY
RIVER AIRE
APPERLEY BRIDGE
NEW LINE
RIVER AIRE
COTTINGLEY
SHIPLEY
BRADFORD ROAD
WILSDEN
WROSE
CALVERLEY
KEIGHLEY ROAD
CANAL ROAD
KINGS
HAWORTH ROAD
TOLLER LANE
MANNINGHAM
QUEENS ROAD
OTLEY ROAD
ALLERTON
BOLTON ROAD
THORNBURY
PUDSEY
THORNTON
MORLEY STR
WAKEFIELD ROAD
STICKER LANE
GREAT HORTON ROAD
MANCHESTER ROAD
TONG
QUEENSBURY
ODSAL
TONG STREET
DRIGHLINGTON
SHELF
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HALIFAX
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a considerable section of the community have become supporters of the policy of Clean Air.

There were as might be expected householders with whom old habits died hard so that they on occasion broke the agreement and reverted to the use of coal. A visit by the District Sanitary Inspector with a warning that a continuance of this practice would result in the ejectment of the offender invariably sufficed so that in no instance has it been necessary to exercise this sanction. In such cases a patient explanation is given of the value of coke and care taken to ensure that the householder thoroughly understands the correct method of using the appliances provided. On follow-up visits it is almost invariably found that continued usage has convinced them that the burning of coke is not without its advantages. They come to appreciate that in addition to constant hot water they have cleaner room conditions, less washing of curtains, no chimney sweeping to speak of and warmer rooms.

The modern solid fuel burning appliance if properly installed is a most efficient instrument but it is by no means fool-proof—it must be operated with intelligence—and it is essential that each ingoing tenant should be given adequate instruction in its use. Care taken in this matter produces a satisfied tenant.

A good quality coke is a necessity. It is no good advocating coke as a fuel if it be burned only with the greatest difficulty. In the post-war house a gas poker is fixed to each appliance, and while this is extremely useful and indeed essential for easy ignition, its ready accessibility leads to its over-frequent use when coke of inferior combustibility is supplied with a consequent increase in the gas bill.

Adequate ventilation is a necessity in any room but it is particularly so in a room heated by coke burned in the modern appliance. One of the most common complaints made by tenants of our post-war houses is that they sometimes experience what they term "the smell of coke fumes" or "sulphur fumes." On occasion these complaints may be supported by medical certificates alleging a deleterious effect of the coke fire on the health of one or other of the occupants, who usually are sufferers from some chronic respiratory condition such as bronchitis or asthma.

As Medical Officer of Health I have been naturally much concerned when a medical opinion is given that the burning of a coke fire is having an adverse effect on the health of a patient. The few cases in which such an opinion has been given have been investigated with particular care—by personal interview with the patient in his house, by draught testing of the flues, by chemical investigation of the room atmosphere at half-hourly intervals throughout the evening's use of the room with windows and door closed. In one such case a partially obstructed flue was the source of the trouble. In others obviously badly drawing flues were responsible; but in the remainder no source for the complaint could be demonstrated, other than intermittent back draughts caused for example, by the sudden closing of the door of a badly ventilated room, or the careless replenishment of the fire by a shovel full or skep of coke. The importance of a good drawing flue is obvious and special care should be exercised in its construction. It is equally important that there should be an adequate intake of air into the room. In the majority of the cases investigated this was not so; the windows invariably being kept closed and in some instances the door and the windows were fitted with draught excluders in addition. This is no doubt a very satisfactory way of preventing heat loss and possibly necessary on the cold slopes of the Pennines, but it does not improve the functioning of a sluggish chimney flue. The use of a controlled method of ventilation such as a hit or miss glass ventilator inserted in a window pane may be a solution. Alternatively a controllable ventilator in the floor by the fireplace, com-

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municating with the sub-floor space is probably better. Tenants do not take kindly to the open window in winter, neither do they like wall ventilators which they usually seal over with paper.

Inadequate ventilation with reduction in relative humidity due to overheating was another possible cause of the complaints made by sufferers from respiratory disease; the consequent dryness of the atmosphere producing an irritant effect on a sensitive mucous membrane causing increased coughing and general discomfort. The escape into the room of the products of combustion of coke or coal will of course, have an adverse effect on the occupant of the room whether he be well or ill. Similarly, overheating of the room may be caused by either a coke or a coal fire, although the very efficiency of the modern appliance when used with coke is probably more likely to produce overheating than the older type of coal burning grate. In every case which I have investigated I have been satisfied that any detriment to health alleged, was due to one or other of the above causes and not in any way due to the burning of coke *per se* instead of coal.

Then there are complaints about the cost of coke, many tenants stating that they have to spend more on fuel in their new houses than they did in the old. The majority however, appreciate that they get more value for any possible increase in expenditure. Undoubtedly those houses with an independent hot water boiler in the kitchen burn more fuel per week than the old house with only one fireplace, but the tenant has two rooms warmed to a comfortable temperature, where before he only had one, and in addition he has constant hot water. In the houses with only one fire with a fire-back boiler, the weight of fuel consumed equals the weight of coal used in the old house but gives greater efficiency.

Although I have discussed at some length the difficulties encountered and the different complaints we have received, it must not, on that account, be assumed that they are many. Over the last eight years from amongst 6,000 families there have been only 22 requests made for permission to use coal, or for transfer to pre-war estates where the burning of coal is still allowed.

On the whole it can be claimed that the operation of this scheme has been a success. There is about it admittedly an element of compulsion without which I am afraid no progress could have been made. Not a single house, however, built by the Corporation since the war contributes in the slightest degree to the smoke pall which hangs over the city for so many days of the year. Almost six thousand houses have now been completed and the value of the City Council's decision in 1946 becomes apparent when we approach a time when fifty per cent. of all the houses built by the authority will be smokeless. Today however, the continuance of the " no smoke " clause in the tenancy agreement is no longer necessary because all the post-war housing estates, some of which will not be fully developed for many years, are designated Smokeless Zones as from April, 1955, by virtue of an Order made under the Bradford Corporation Act, 1949. The combined areas amount to 1,500 acres. The tenancy agreement scheme may now be said to be outmoded in Bradford, a " black area " because of the probability that future progress in smoke abatement in the city will be through the smoke control area provisions of the Clean Air Bill. It will be advantageous to take the opportunity given to treat municipal and private buildings similarly. The policy adopted will depend upon the extent to which the Minister finds himself able to confirm the many smoke control orders which will almost certainly be made. It is doubtful if authorities outside the black areas will be able to make use of this provision of the Bill for many years to come. To them smoke control in housing estates by tenancy agreement is commended.

Pre-War Municipal Houses

So much for the post-war house and the operation of tenancy agreement method of control of smoke, a method which the City Council have hesitated to apply to existing tenancies on pre-war estates.

In recent years however the Council has arranged for the replacement of the old fashioned cooking ranges in such houses by modern fireplaces selected by the tenant who is not restricted to the approved appliance or to a particular fuel. The conversions are carried out by the local authority who recoup themselves by adding eight per cent. of the cost to the rent.

It is interesting to note that out of 3,000 conversions only seventy to eighty have been to approved appliances capable of burning coke, an interesting illustration of the backwardness of public opinion in a city where so much publicity has been given to the benefits of smoke reduction and the value of smokeless fuels. The element of compulsion contained in the Clean Air Bill is obviously necessary if any progress is to be made. The introduction of the tenancy agreement scheme for pre-war houses in Bradford or elsewhere in a black area is not worthwhile, in view of the financial advantages to both Corporation and tenant contained in Clauses 9 and 10 of the Bill which deal with conversions to approved appliances in Smoke Control Areas. The declaration of a Smoke Control Area also has the advantage already pointed out of enabling private and municipal property to be dealt with in the same way.

In this paper I have tried to indicate the preliminary steps taken in the post-war years in a fairly large industrial area to initiate a drive for smoke abatement and fuel efficiency in domestic premises. Whether we like it or not this country will have to face further rises in coal prices due to increasing scarcity and rising production costs. The experts tell us that the fuel situation will be critical in the 1960's. This national predicament raises the question—Are we using our fuel supplies efficiently? The answer in most cases is a very definite NO.

In conclusion I wish to express my appreciation of the assistance I have received, from Mr. Frank Myers, Chief Sanitary Inspector, City of Bradford, with the preparation of this paper. I would also thank Councillor Arnold Walker, Alderman Kathleen Chambers, and the present Lord Mayor, Alderman R. Ruth, for their continued support of Smoke Abatement in the city during their Chairmanships of the Health, Housing and Public Works Committees, by their championship of the tenancy agreement clause and the Smokeless Zone policy.

Discussion

F. J. Redstone, Sessional Chairman, before the presentation of the papers, said that this session was most important because contributions were to be made by representatives of Local Authorities and their officers who would be concerned with the implementation of the new Clean Air Act.

The success or otherwise of legislation depended to a very great extent on the interest taken by local authorities in the matter and the enthusiasm shown by the officers charged with these important duties.

It was not his intention to stand between conference and the speakers who had given so much thought to the preparation of their papers and on this note he proceeded to introduce those taking part.

Dr. Douglas in introducing his paper said that those whose interest and work lay in the field of public health had long ago accepted the thesis that clean air was just as essential as clean water. He thought it was true to say that the average citizen would take the same view and that he would be delighted at the prospect of a bright clear atmosphere in place of the smoke-laden air it was his misfortune now to breathe. When it came to asking that individual, however, to play his part in producing these most desirable conditions, it was a very different matter.

It would be agreed that education and persuasion were the best means of securing the co-operation of the public, and striking advances had been made in Public Health and Preventive Medicine by this means—diphtheria immunization for example—but the difficulty in selling the idea of clean air was that there were not sufficient inducements to offer his fellow citizen so that he, of his own free will, would play his own important part in reducing pollution.

Although many were convinced of the deadly effects, in the long run, of the products of combustion on the human organism, we were not yet in a position to advance such strong and convincing arguments or use propaganda of the type so successful in the diphtheria immunization campaign.

Sir John Charles' lecture at the Glasgow meeting would be remembered in which he emphasized the need for more research. "Far too frequently," he said, "the blunt weapon of assertion has been preferred to the precision tool of proof." The general public were not easily convinced—especially those who live in the North.

The London smog and its results were of great propaganda value in certain quarters—without it, it was doubted if the Beaver Committee would have been appointed—and he congratulated the Society on the good use it has made of the occurrence but he doubted if it really had had such a profound effect on the public as we were inclined to think.

Dr. Douglas expressed his disappointment at hearing Mr. Nabarro tend to minimize the contribution that domestic smoke makes to the sum total of pollution. He was quoted in the previous night's local paper as follows: "He felt that little would be achieved by attacking domestic chimneys." The statement should be read, of course, in the context of his other remarks. Out of context it has a stronger meaning than he intended to convey. *Dr. Douglas was of the opinion that it was the domestic user who was so important.* There were no more enthusiastic advocates of clean air he said than the tenants of Bradford post-war houses who themselves of necessity burned smokeless fuel. They were the people who were most vociferous when factories on the outskirts of their areas belched forth black smoke. Public opinion must be behind social legislation of this kind and if everyone was convinced that clean air was an absolute necessity like clean water, there would be little trouble in getting the industrialist to toe the line.

He therefore welcomed the Clean Air Bill with its element of compulsion as being necessary to direct the average man to protect his own health and to see to it that it was not damaged by others. But, he said, what the local authority representatives wanted to know (to employ a phrase used by one of the speakers yesterday) was, what was the user reaction to the compulsory burning of smokeless fuel? He was glad to report that on the whole it was good. A pilot survey conducted on the Bradford post-war estates during the last two months showed that the great majority of the tenants were well satisfied, and that although they had been more or less

forced to subscribe to the policy laid down by the Corporation, they had accepted this with good grace and by usage had become accustomed to the burning of coke, and many of them today, he was very glad to say, were enthusiastic supporters of the Clean Air Policy of this Society.

G. H. Barnard (N.I.F.E.S.) said that previous speakers had referred to the training of boiler operators being a prime factor in establishing "clean air." The Board of Directors of the National Industrial Fuel Efficiency Service was convinced that the quickest way to reduce smoke and fuel costs was to make sure that your boiler operators are properly trained.

In many places local difficulties precluded the formation of courses at technical colleges. The age groups of the men involved, the need to work shifts and difficulties of travelling often acted as a deterrent to intending students. After consultation with the Ministry of Education, an alternative scheme of study—the N.I.F.E.S. Course of Training for Boiler Operators—had been devised to meet the needs of men who found difficulty in attending a technical college course.

The N.I.F.E.S. course was available throughout the country and had been designed to meet particularly the needs of smaller and medium-sized firms. The course consists of practical training on selected boiler plants by qualified N.I.F.E.S. engineers, coupled with home study material which was sent to each man by post. Where possible each man would be trained on a plant similar to his own. The course lasted 21 weeks and consisted of six three-week instruction cycles and a three-week revision period. In each instruction cycle the men received by post enough home study material to prepare them for one day of practical instruction on site in the third week. For this practical instruction, men from boiler-houses with similar plants were gathered at a selected plant in small groups (maximum 16 men). At this group meeting each man had a chance to discuss problems that had arisen from the home study material. A weekly test paper was sent to each man and this paper would be returned to the home study tutors for correction. From the home study material, corrected papers and the practical instruction, the men would have every chance to find out not only how their boiler plant and auxiliaries worked, but also why.

By taking the course to the man, the difficulties of shift work, irregular hours and the variety of plant and equipment could be overcome and each man was trained in the more efficient operation of his own type of plant. In other words the course was a form of training within industry.

The course was essentially practical in bias. It was designed specifically to appeal to the man working in the boiler-house, irrespective of age, and to encourage in him the efficient economical use of fuel—a practice which may well be directly to his own advantage.

The course prepared men for the Boiler Operator's Certificate Examination of the City and Guilds of London Institute.

Councillor John McKee (Bradford) congratulated Dr. John Douglas on his paper, which he said, gave a very full picture of the Bradford position with regards to steps taken since the war to combat the smoke problem within the city, and no doubt the conference would be especially interested in the way in which Bradford had got over the domestic smoke question so far as post-war houses were concerned.

On the question of industrial smoke, Councillor McKee suggested that industrialists should increase the wages of boiler firemen who had passed a qualification course. Saying that classes for boiler firemen had been well attended over the past few years, Councillor McKee said he thought it would encourage more men to take the course if there was a "floating firer" at the mills, who could take over while a man went to his training classes.

It was difficult, he said, to get a man to go to the Technical College in his own time after a hard day's work, adding, that industrialists could well afford, in these days of incentives, some extra money in the wage packet for a man who passed the course, and not only would this assist in the clean air campaign, it would also cut fuel costs, said Councillor McKee.

Referring to Councillor Gibbons' paper and the question of councillors who supported unpopular legislation, being in fear of losing their seats, Councillor McKee stated that one Bradford councillor, Arnold Walker, who advocated clean air after the war when, "many of us could be classed as doubters," was still a member of the City Council, still represented the same ward and, what was more, was more popular than ever.

W. C. Moss (Coal Utilization Council) wanted at the outset to say that his Council was concerned with the efficient utilization of all solid fuels, including smokeless, and was wholeheartedly behind the efforts of the Society towards cleaner air in Britain.

Mr. Moss said he had to some extent been reassured on his first point by Mr. Nabarro's evidently clear grasp of the situation the previous day, but was anxious in the presence of so many local authority representatives to stress that the inception of smokeless zones or smoke control areas should not be allowed to outstrip the production of increased quantities of solid smokeless fuels. If they did, the public would be driven, against the Government's policy, to the use of the much more expensive fuels for main winter space and water heating and public opinion turned against the whole idea. Secondly, he wished to stress the value of underfeed and other mechanical stokers which could burn bituminous coal with no smoke, or practically none, and hoped that local authorities would not set their face against the use of bituminous coal in principle, at least until the ratio of 35 million tons bituminous to 5 million tons of smokeless fuel was reversed. He knew it could be argued that these stokers did occasionally make a very little smoke (so did oil burners), but he felt that for the good of the cause as a whole a sense of balance was necessary, and he maintained that the man who used bituminous coal on a suitable stoker thereby releasing a fair quantity of smokeless fuels for smaller consumers who could not use stokers, was pulling his full weight and should be encouraged.

Mr. Moss was glad to see his friend, Mr. McGrath, Chief Sanitary Inspector of the City of London, at the Conference, since he believed him to be a man with his feet firmly on the ground in these matters, and for that reason Mr. Moss believed, as he was sure the whole Conference hoped, that the City of London smokeless zone, then within hours of its birth, would be a complete success.

He said that his third point was perhaps a smaller one, but important, since it was concerned with retaining the goodwill of the public, which was essential. It was a plea that in houses where no gas was laid on, or even where a gas service was not extended to the room in question, the use of wood for igniting smokeless solid fuels should be permitted.

The Coal Utilization Council was completely in favour of gas ignition, but attempts to forbid the occasional and harmless wood smoke in houses with no gas, were inflicting unnecessary hardship and driving the occupier either to the expense of installing gas or to the use of electricity. In that connection he was horrified the previous day to hear a contributor to the discussion ask for a complete ban on solid fuel. Gas and electricity had their place for short period heating and summer water heating, but to drive people to electricity for main heating reminded him of Marie Antoinette's famous remark: "If the people haven't enough bread to eat, why don't they eat cake?"

G. W. Farquharson (Midland Joint Advisory Council for Smoke Abatement and Atmospheric Pollution) stated that in his opinion the papers given indicated that the Bill, in its present form, would bring very little more pressure to bear on industrial plant users, but would enable local authorities, if they so desired, to introduce smoke control areas without the expense of promoting private Acts, and whilst some authorities may be most anxious to create such areas, it should be remembered that Ministry control, not only by the Ministry of Housing and Local Government and the Ministry of Fuel and Power, but also the Treasury would be the overall authority regulating the rate of flow of the establishment of such areas.

The Bill hid a lot of controversial matters, for example, the time limits of dark smoke that will be permissible, and the extent and number of the trade processes which will be transferred to the Alkali Inspectorate control.

Mr. Farquharson asked for an opinion from any of the speakers on the setting up of a Clean Air Council, and making compulsory the question of Annual Reports to the Minister on progress in smoke abatement. These recommendations were in the Beaver Report but not in the Clean Air Bill.

Nothing that had been said at the Conference had caused him to alter his opinion that it would be best to call the new Bill the Partial Clean Air Bill.

The legal draftsmen had left so many means of escape, that whilst the front stable door was locked and barred, they appeared to have neglected the means of escape by the back door.

J. W. Batey (Sheffield) said that the Bill was the offspring of the Beaver Report and as such the Beaver Committee must bear a large share of responsibility for its contents. In so far as having any offspring at all after a Government Committee was no small feat; the Beaver Committee were to be commended. In the last hundred years five such committees were counted who had examined the problem but who had never been successful in obtaining any legislation whatever; but if the Bill was accepted as it stood, the offspring would be stillborn—strangled by timidity; denied the breath of life by ineptitude.

The first Section was most commendable but as soon as line 10 was reached, it was found that the Minister was given powers to exempt " classes of case " and " limitations as may be specified." Unless the Minister's discretion was applied with the greatest discrimination and only in exceptional circumstances, the power in the Bill to license smoke could not be denied.

It was stated that three well-nigh impregnable barriers to successful smoke prosecution were built up by the Clean Air Bill, namely: lighting-up, failure of apparatus, and unsuitable fuel.

The unsuitable fuel defence could hardly ever be rebutted; for the fuel alleged to be unsuitable would necessarily have been consumed during the commission of the offence, and the defendant would always state that it was the best he could get and that in any event its unsuitability only came to light when it actually produced dark smoke instead of the light haze which he had been led to expect. Unforeseeable technical difficulties would also be pleaded and those two defences would either exonerate or severely mitigate the offence.

Lighting-up of furnaces could be accomplished either carelessly or with a minimum and defined standard of smoke emission.

Where maximum strength was wanted in the Bill there was a maximum weakness which was not even thought of in the outdated legislation contained in the Public Health Act, 1936.

In considering the grit and dust paragraphs commencing in Section 4, the immediate difficulty of " any practicable means " arose and when the definition of practicable was looked for in Section 28 it was found that it was fatal to the purpose of the Act. It was wrong that regard should be had to cost and other financial consequences. If the aggregate cost to the nation of a polluted atmosphere could ever be balanced against the cost of preventing it, local authorities would be the first to peruse the balance sheet. Since there never was and never could be such a balance sheet, why should a court look at one side of the account only, and if they were required to do that, how could they ever produce a fair result? The cost of preventing atmospheric pollution would be regarded as a proper charge against the profits of any undertaking just as the cost of abating any other nuisance would be.

Secondly, regard should not be had to local conditions and circumstances, otherwise a heavily industrialized area, the atmosphere of which was already polluted, may have to accept pollution for the indefinite future.

The ineptitude was shown in the use of the word " practicable." No less than twelve times in the first 13 pages of the Bill (which were the pages that mattered) was the word used, with varying grades of qualification.

The greatest disappointment of the Bill probably lay in the grit and dust provisions. No standards were laid down whatever. If a firm had installed grit arrestment apparatus and were not using it or allowing gross inefficiency in its use, how could the local authority take suitable action? How could indentification of the particular chimney be established? What proof could be brought on a quantitative or qualitative basis that a particular chimney was emitting grit? Could a firm not say that by damping the coal or reducing the draught, or other such nebulous conceptions, that they had minimized the emission of grit and dust or indeed, that they were not producing it at all? It might be argued that the measurement of grit and dust was difficult or not possible, but the Bill itself showed that grit measurement was not only possible but essential, for Section 6 asked for such measurements from large furnaces—furnaces which, apart from power stations, did not exist.

Turning to the exempted processes, and in particular to metallurgical processes, it was stated that they were first exempted in 1875, exempted again in 1926 (with the possibility of the exemption being lifted within five years), written into the 1936 Act, added to by the Beaver Committee and were now being threatened in this Bill. It was nonsense to suggest that no progress had been made in the metallurgical industries for nearly 100 years.

To sum up; a normal evolutionary process in this country was for a few individuals, or a group, or Corporation to take action, one way or another, against some bad practice. Interest was aroused and sooner or later legislation ensured. That process had taken place once again, but that legislation would not measure up to the problem, it was too timid, there was too much smoke and dust in it—and not enough fire.

Dr. W. C. Turner (Chelsea) said that one of the most vexed questions on the Bill was its administration. His plea was that if we wanted clear air, we must have clear thinking.

To his mind, it was quite clear-cut that we must take a realistic view of the whole situation *vis-a-vis* the aims of the Society. The day-to-day administration, supervision and power to apply sanctions must lie with the people who have to put up with the nuisance—that is, with the local authority.

The officer whose interest and training best fitted him for the job was the Sanitary Inspector, but we must face the facts. Recruitment to this calling was falling off and there were deficiencies throughout the service. Further, the solution of many of the technical problems involved were frankly beyond the capacity and training of a Sanitary Inspector, and Dr. Turner felt sure that he would be the first to admit that. In the circumstances, therefore, we should not in fairness expect too much from that section, or overload it in spite of its obvious enthusiasm.

Expert scientific and technical advice should be readily available and forthcoming from the Alkali Inspectorate, enlarged in all branches of scientific and mechanical engineering, working in the closest liaison with the appropriate research sections of the Department of Scientific and Industrial Research, so that actual problems would have applied to them the immediate benefit of current research and knowledge.

It must be remembered that the sole aim of the Society was the total abolition, if possible, of aerial nuisance, and the achievement of clean air. We were a polyglot society and must not permit emotion or pressure from sectional interests to cloud the issue and delay the achievement of our ideals. There was a lack of scientists and technicians, and we must of necessity accept the scheme which permitted the greatest flexibility and uniformity of application throughout the country, with the most economic distribution and use of the available manpower, so that if necessary satisfactory solutions could be arrived at as the result of teamwork rather than the whim of an individual. It must be remembered that it was by education alone that we would achieve the most lasting improvement from recalcitrant smoke producers.

G. Nonhebel said that it was of the utmost importance in order to secure favourable user reaction that the grate bar spacing in open coke fires should be suitable for the local coke available—see Beaver Report, Appendix IX, para. 6(*a*). Most approved open fires were a compromise, suitable also for coal. For coke only, if there were to be a really bright fire and good pick-up on refuelling, the Gas Council recommended bar spacings between $\frac{9}{16}$ and $\frac{11}{16}$ inch. He preferred the latter, having had investigations made in his own home during his service on the Beaver Committee. Moreover, he was of the opinion that manufacturers of open coke fires should always supply as an essential tool the special flat-ended " pokers " so desirable for clearing ash from between the grate bars before refuelling.

N. Bastable (Barking) said that he wished to address his remarks to Alderman Smith in particular reference to the proposed yardstick.

He felt that before the public would accept a clean air policy it would be necessary to build up a climate of opinion which would recognize atmospheric pollution as a breach of good behaviour and would be recognized as readily as the contravention of the 30 miles speed limit by the offending motorist.

He continued by saying he, some five years ago had advocated the use of a name such as " Fug," for national standard of emission in the same way as the electrical terms volt and watt were used to measure electricity.

Mr. Bastable then dealt with the time wasting smoke observations which it was necessary for local authority officers to carry out at the present time and compared such waste of time with that of " speed cops." He said that offenders, whether they be smoke offenders or speed offenders were both a menace to the public and were both subject to penal control. Industrialists and motorists at heart were all law-abiding citizens but took a chance on many occasions.

Industrialists were no less conscientious than other members of the public nor are local authorities any less reasonable than the courtesy policeman. He urged that these time-wasting observations should cease.

He said that there were available today smoke recorders that had been proved reliable. They were installed in all power stations of the Central Electricity Authority and were required to be used in the City of London where the Corporation of that city permitted the use of authorized fuel.

He urged all local authorities to take the necessary steps to ensure that the Clean Air Bill was amended to provide for the compulsory installation of smoke recorders on the panel of every boiler furnace in the country.

Miss Dorothy Boyd, an individual member of the Society, welcomed Mr. Nabarro's injunction that " Coal must Work " but was dismayed at his apparent inference that nothing much could be done about the domestic consumer.

Since the Simon report announced, and the Beaver report confirmed that half the smoke in this country came from domestic consumption, the domestic consumer had an important part to play in the campaign for clean air.

She said whilst it was incumbent on members of the Society to promote knowledge among domestic consumers of the benefits of solid smokeless fuels it was maddening to be exhorted to use fuels which were so often unobtainable. It was therefore also necessary to point out ways in which more economic and efficient use could be made of whatever solid fuel was available.

She was of opinion that more use could be made of flue control plates in conjunction with ordinary overnight burning stoves and indeed the old stool bottom grate and quoted some instances in widely varying conditions where great improvement in heating and economy in fuel consumption had resulted from the use of such simple equipment.

The insulation of hot water tanks and pipes was a further useful aid to economy.

She had found that domestic consumers were anxious to know more about the economic use of fuel and she concluded that whilst small in themselves, such economies could, if widely practised, make a useful contribution to the whole.

A. H. Basford (West Hartlepool) underlined Mr. Graham's reference to the value of regional advisory committees. The situation on Tees-side had benefited by the activities of the Tees-side Smoke Abatement Advisory Committee whose technical sub-committee provided a reservoir of technical knowledge and experience far in excess of the limited resources of the individual constituent authorities.

He also commented on the plight of " people unfortunate enough to live in the vicinity of engine sheds." West Hartlepool Corporation had approached British Railways to secure a reduction of smoke nuisance from the town's engine sheds but without success because British Railways had decided, presumably at regional level, that the expense of works to provide material relief to the residents of the area would not be justified. He thought British Railways should not be the arbiters of such matters, certainly not at regional level, and suggested the insertion of a clause in the Clean Air Bill giving the Minister of Transport the same responsibility for the undertaking as obtained for Crown property in Clause 17. Alternatively British Railways should consider at the highest possible level complaints made to them by local authorities and take positive action without undue delay.

A. C. Hazel (Hurseal Ltd.) said he wished to correct the misapprehension which he detected running through the discussion that morning and which he also noticed applied to much of the discussion the previous day. A great many people were talking about modern appliances at the conference and he found that they were thinking in terms of the so-called " modern " grate. That grate did not use less fuel but fortunately for the conference, there was on the market now for the first time a completely new type of free standing open fire which provided convection and which had a restricted throat and provided low-down radiation. These adaptor fires as they were called used about half the smokeless fuel used in the so-called " modern " grate and provided a much higher standard of efficiency.

He wished to emphasize the fact that these appliances used half the smokeless fuel. Thus in all calculations regarding the future one could bear in mind that at long last householders could install an appliance which was bound to use less

smokeless fuel, and in fact it was a physical impossibility to use as much as was used in the ordinary open fire.

Councillor T. E. Morgan (Mynyddislwyn) said that he wanted to base his remarks on Clause 14 of the Clean Air Bill, which dealt with colliery spoil banks; or rubbish tips, as they were known in his area, with the accent on rubbish. Delegates would readily agree that the largest producer of smoke and dust in this country was the coal mining industry. Speaking as a colliery official supervising the operations of coal production, he deplored the large amount of rubbish now being deposited on rubbish tips throughout the coal fields. Much, if not all that rubbish would be better used for packing the mined areas underground. Subsequent governments would be faced with heavy bills for compensation for subsidence of land and property caused by the methods of coal mining now being practised. Dust suppression in the coal mines of the country was producing excellent results in providing better working conditions underground. The rubbish now being tipped on the surface and hillsides away from the collieries, regardless of siting, formed the antithesis of dust suppression. The prevailing winds carried materials to areas far distant, distributed dust and grit along the highways and byways of our once beautiful countryside, coloured the outside and ornamented the inside of our houses, schools, churches and public institutions with undesired matter. The Government's Clean Air Bill dealt only with smoke and fumes arising from the tips made after the passing of the Bill. That was only a mild and ineffective antidote to the poisoning of the atmosphere.

He asked for abolition of rubbish tips, since prevention was better than cure. That would be possible, given good intelligent planning in the industry, and the co-operation of all workers concerned would result in a valuable contribution being made to a Clean Air Bill. He spoke as a councillor of a local authority in a mining area, and the effects of grit and dust on the health of the population caused him deep concern. The unsightly tips, now forming large tracts of the countryside, were unpleasant monuments to an inefficient industry.

S. Cayton (West Bromwich) said that local authorities should lead public opinion by example, no less than by precept.

He went on to say that open coal fires were still being used to heat public offices in town halls and elsewhere; that the boiler houses of the public baths left much to be desired, and its chimney was still amongst the guilty.

He said he realized he was speaking to the "converted," but questioned whether all the elected representatives at home could be so described. The extent of air pollution could be measured, he said, and even one deposit gauge would show that smoke knew no boundaries and might even reveal striking information. He urged the setting up of deposit gauges where they did not already exist as a valuable means of education.

Alderman Mrs. Julia H. Engwell (Barking) said that she was surprised when she heard Mr. Nabarro refer to domestic smoke and suggest that emissions from such chimneys were unimportant. She had always understood that domestic smoke represented 50 per cent. of the pollution of the atmosphere and certainly any study of soot deposit gauges would show a substantial rise when home fires started in the autumn of the year. That was true of Barking where there were four deposit gauges and monthly readings were taken.

Alderman Mrs. Engwell was also concerned to see that occupiers of houses who wished to make their contribution to a cleaner atmosphere should be assisted with a subsidy for space heating by electricity or gas.

She said if local authorities were able to assist occupiers to install modern fire appliances, the same assistance should be available to families who changed over to gas or electricity, and if such subsidy could not be paid by the local authority it should be provided in the form of a special tariff.

At the conclusion of the session the Chairman thanked the speakers and all those who had taken part in the discussion, making special reference to the tremendous amount of work put into and the interest paid to this and many other matters by the elected representatives of local authorities. Very often one heard appreciation voiced about the work of officers but it must be appreciated that little effective work could be carried out without the vital interest and encouragement received from local authority committee members.

Councillor Eric Gibbons, replying to the

discussion, said he too had been let off lightly, as there was only one point on which he had to reply, raised by Councillor John McKee of Bradford. He was very pleased to hear about the case of Councillor Arnold Walker, and hoped that when the question of smokeless zones came before the various local authorities the elected representatives who were delegates of the meeting would remember the case of Councillor Arnold Walker, who as a result of his work on the Bradford smokeless zone had become one of the most popular men in that city.

J. Graham, in reply, endorsed the remarks made on the importance of the training of boiler operatives and stressed the value of the example of local authorities in providing wage increases on certification.

Concerning smokeless means of ignition of solid smokeless fuels, the convenience of the use of gas was unquestionably widely recognized, either for such fuels or coal, irrespective of a clean air policy and should be encouraged.

On a question as to the absence of any proposal in the Clean Air Bill to implement the Beaver Committee's recommendations on the formation of a Clean Air Council and annual reports from local authorities, he commended their value in identifying accountability with responsibility.

Whilst fully agreeing with the necessity for numerous amendments to the Bill, especially the escape clauses, it did form a major advance toward a cleaner air.

On comments relating to the relative executive responsibilities of central and local government he thought that the significance of the probable transfer of some responsibility for the control of smoke arising directly from scheduled processes tended to be exaggerated. Clearly, in any event, the public would not mind who was responsible so long as the job was well done.

In reply **Dr. Douglas** said there was little he had to say except to express agreement with those who spoke on the use of smokeless fuel burning appliances. He emphasized Mr. Cayton's point that local authorities themselves must lead the way in converting appliances in all their municipally owned buildings to the burning of fuel without the creation of smoke.

Once again, he stated, we have had a most successful Conference and we would all seem to be enthusiastic advocates of the cause of clean air. He concluded by expressing the hope that all those attending the Conference were themselves following the advice they gave to others and burning nothing but smokeless fuel or its equivalent in their own homes.

CONTRIBUTIONS BY MEMBERS OF THE BEAVER COMMITTEE

SOME HOUSING ASPECTS OF THE BEAVER REPORT

by

Miss A. D. Boyd B.A., F.S.H.M.

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The Beaver Committee propounded a solution of the domestic smoke problem. A large section of public opinion now gives positive support to the principle of clean air and there is no apparent opposition to that principle. To put the principle into practice does, however, call for considerable changes in our domestic habits and if people are to make these changes, they must be convinced not only of the desirability of the end to be attained, but also of the necessity of the means to that end. To convince people that if they want clean air they must alter their ways of heating their homes, and that without this, clean air cannot be attained; that is the task ahead.

The Report recommends, as means of reducing domestic smoke, the establishment of smokeless zones and smoke control areas and the use of approved types of domestic heating appliances in which smokeless fuel is to be burned. What is likely to be the public reaction to this, when the local application of the principle to which they have given lip-service, means that they themselves must go to trouble and perhaps expense, in replacement of appliances, and must learn to use an unfamiliar fuel against which they are prejudiced and which they regard with doubt or scepticism?

It is useful to remember the wide range of people affected since this is likely to result in differences in opinion on the means of achieving clean air. For instance, of the 13½ million individual dwellings in Great Britain in November, 1953, 3¾ million were owner occupied, 2½ million were owned by local authorities, new towns, housing associations and similar bodies, and 7¼ million were rented from private landlords. The enlightened landlord, public or private, encouraged by the financial assistance which is recommended, will realize

that his own expenditure will improve his property and enhance its value. The tenant, provided with modern and efficient appliances, may face with some doubt the need to learn to use them properly. The owner-occupier, who should also receive financial assistance, would also improve his property and would share with other occupiers the material advantages of clean air.

Opinion on clean air is also likely to vary between industrial and non-industrial areas. People living in industrial areas, where there is most need for improvement in the state of the atmosphere, often seem defeatist about it. There are two main reasons for this. One is the folk-lore adage, " Where there's muck, there's money." This may have been true in the past but of course " muck " is often a sign of inefficiency and nowadays there is plenty of money in places where there is no " muck." A more serious reason for this defeatism is the fact that the housewife in an industrial area does not believe that the smoke from her and her neighbours' chimneys makes any significant contribution to the smoke of the district. When she sees smoke from the chimneys of the mills and steel works joining that from the power station and the slag heap, to form a pall over her head, she thinks that her small addition to it makes no difference. It is no use to quote figures of the amount of smoke from domestic sources as compared with that from industrial sources. She goes by what she sees and she is of course right, up to a point, since in an industrial area the greater volume of smoke, particularly in summer, may well be from industry. By comparison, the family in the non-industrial area is far readier to believe that there is some advantage in domestic smokelessness.

How can these genuine difficulties be met and these objections answered? Usually people are more readily convinced by demonstration than by theory and by the experience of their neighbours than by scientific proof. The most effective piece of propaganda is a successful smokeless zone or smoke control area. Fortunately we already have some experience of smokeless zones and also of municipal housing estates where the use of smokeless fuel is a condition of tenancy. This shows that the following practical points are of the first importance:

(1) Before any such scheme is started, it is essential to ensure that a steady supply of good coke of consistent quality can be guaranteed. Failure to do this may easily result in failure of the whole scheme.

(2) The fuel burning appliances chosen must be suitable for the job they are required to do and for the fuel they are to burn.

(3) The appliances should be of simple design, good workmanship and easy to operate and to clean. They should be of good appearance and should be tough enough to stand up to occasional rough and careless use. It should be remembered that housewives, though the majority are careful and sensible in the use of their equipment, are not scientists or engineers and have little patience with apparatus which needs frequent and precise adjustment.

(4) Appliances must be properly installed. There is considerable room for improvement here; the work done in this respect by the Coal Utilisation Council and by many manufacturers is greatly appreciated and it is hoped that it will increase. There is need for more training for those who install stoves and more readiness to make use of the training facilities available.

(5) Correct use of the appliance and the fuel must be ensured. Every user should have a copy of the manufacturers' instructions on use and manufacturers should be willing to supply extra copies of their instructions since these are easily lost or mislaid. Advice on use may, of course, be obtained from the C.U.C. and in the case of publicly owned houses, from the landlord. It would be very helpful if the fuel suppliers

could also assist, as they do in some areas.

(6) Appliances which are intended to burn coke should be provided with means of gas ignition. This alone would do much to overcome reluctance to burn coke.

(7) Sufficient fuel storage space should be provided. Nearly twice as much space is required for coke as for the same weight of coal. This is a point to be borne in mind when building new houses or flats. To help flat-dwellers in particular, it is hoped that before long, more convenient methods of packing and delivering coke may be evolved.

(8) Stove recesses in which stoves may be installed and from which they may be easily removed, have great possibilities. They overcome one obstacle in the way of the tenant who wishes to improve the house he lives in, since if he installs a stove in the recess, it does not become a landlord's fixture and may be removed at the end of his tenancy. Such an arrangement also facilitates replacement of the appliance by improved types.

To adopt on a large scale the recommendations of the Beaver Report will mean changes in our domestic habits. As a nation, we are perhaps conservative and slow to change, but change we do, nevertheless. If public opinion can be convinced by demonstration that clean air depends on the efforts of the householder as well as of the industrialist, we are well on the way to achieving our aims.

THE BEAVER REPORT AND AFTER

by

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1. The Beaver Report opened a new and important chapter in the fight for safe and clean air. Local authorities may not have realized the truly great responsibility and challenge with which they are now confronted. There is the challenge for example of the " black " areas where 24 millions of our people live, where 19 million tons of raw coal are burnt every year, where fogs are most frequent, where the grime and gloom is the greatest, and where death and illness from respiratory disease is highest. The greater the challenge, the greater our response must be.

Smoke Control Areas

2. The public must accept restrictions on the use of raw coal for domestic purposes—I think they *will.* The prospects for clean and safe air were never brighter.

Keen as I was and am on the smokeless zone principle in which selected areas, such as civic centres in towns should have no smoke at all, yet one must recognize that by far the greatest good will be done by the smoke control areas. If we could get 80 per cent. reduction of pollution in our towns, life would be transformed. In the present state of knowledge, the remaining 20 per cent. of pollution, it must be admitted, will be most difficult and expensive to reduce in any area, and impossible in most. But, as a result of the Beaver Committee's Report, a great deal more research is now going on, and in the long term the problem may be solved.

We must recognize that complete smokelessness is not generally practicable in areas which include industry, and that open fires are likely to remain the usual means of heating British houses for many years to come.

3. *The right start.*—It is of great importance to start rightly. How easy

A Smokeless zone in a residential area in Salford

it is to make an area smokeless from the very start! The shining examples of Nottingham and Bradford point to this being the method of choice. In these two cities large areas have been smokeless from the start (for it was, and is, a condition of tenancy that smokeless fuel be burnt) and the troubles and complaints are negligible. How difficult it is to make an area where large numbers of appliances require conversion and where the tenants have used raw coal from time immemorial to switch over to coke or other smokeless fuels. Habits become fixed and the tenant thinks "why should I bother?" The coal dealer is accustomed to bringing raw coal into the area and it is easier to accept what he has. There is a score of other difficulties.

4. *Salford experience.*—Let me describe the task which faced the Salford Council in making two zones on residential property in the city smokeless. Let me claim for them at once that despite some inevitable teething troubles, to which I refer below, a solid success has been achieved. I will not say that no wisp of smoke has ever been seen; in the early days particularly, the Nelsonian eye was directed upwards. Despite the difficulties, foreseeable and unforeseeable, the Salford citizen can look with pride and pleasure at the achievement of a cleaner air in these zones.

5. *Inspection.*—With regard to the inspection, this is done by the district inspector who is also the smoke abatement officer. He observes a domestic chimney just as he would observe a factory chimney, but of course his task is easier, for if he sees any smoke at all, that smoke is an offence.

The Clean Air Bill

6. One of the most attractive features of the Clean Air Bill is the emphasis on *flexibility* in the size of the control areas, in the type of fuel which can be burnt, of the timing of the coming into being of the areas. In the past the rigidity of conditions

in local legislation hampered us. In my own area the Smokeless Zone Order had to come into force six months after it was made—this meant it came into operation on 1st January, to be promptly followed by the coldest spell of weather we have had for years. Deliveries of fuel on the icy roads were affected, a dozen delays in conversion of grates occurred. Local authorities contemplating the establishment of smokeless zones or smoke control areas might wish to bear this in mind, for clearly the best time for such areas to come into operation is in the spring or in the summer. All connected with Local Government know the frustration which follows finding the money and doing preparatory work, before carrying out a new project. We received the final Council " go ahead " only three weeks before the Order became operative, and that included Christmastide when housewives don't exactly like their living rooms disturbed.

Survey on Smoke Control Area

7. This needs care, and fortunate is the area which will be able to devote sanitary inspectors to this work under the direction of a good smoke abatement officer; for most areas I would plead for the appointment of technical assistants working under the direction of sanitary inspectors, whom we have found very useful in our housing survey work. Fortunate too, is the area that can take measurements of air pollution before a smoke control area is established and after.

In the first place, however, a decision is required as to the size of the area within the resources of the authority, and the supplies of smokeless fuels. Due regard to the direction of the prevailing wind is a small but useful point. A form is compiled in respect of each house, showing the type of existing grate and the quantity of fuel used. In my area it averaged 43 cwts. compared with the national average of 47 cwts.

In the second place, it is essential to ensure that the necessary supplies of smokeless fuels together with the appliances are available. It is most important that these things should go hand in hand. There must be early consultation with all those who will provide the smokeless fuel. Far too often in the past we have avoided difficulties by not including industry in these areas, but in view of the findings of the Beaver Committee and the provisions of the Clean Air Bill there is no longer any need to exclude industry from such areas. Furthermore, our work will be gravely hampered if we do, as we shall be faced with the perfectly legitimate complaint of tenants of domestic dwellings in smoke controlled areas who will say " why not deal with so and so's factory chimney first." Far from " skirting round works " therefore, our areas should include factories; for the opportunity can be taken of consultation and collaboration with industry to see what they can reasonably and practicably do to reduce their emissions.

8. *The coal dealer.*—The coal dealer is an important member of the air pollution prevention team. We must recognize his difficulties. In the past the profit has been smaller on coke; coke has been bulkier; transport and delivery charges have been higher. After all, its cash that counts with the coal dealer. We have had meetings with dealers who have shown much co-operation. We recognize that the tenants on most estates are not exactly air pollution abatement enthusiasts. Many are apathetic and will take no steps to change their supply of fuel. The dealers have helped us by delivering smokeless fuel and persuading the " couldn't care less " tenants that to use smokeless fuel was " the thing to do."

9. *The need of education—the making of a good fire.*—The right appliances should be carefully chosen. Not all approved appliances give complete satisfaction in particular areas. Local authorities must listen to the advice of the appropriate officer. The right education of the housewife in this matter is an opportunity for progressive authorities, and an advisory

service in a smoke controlled area in the early days of the operation of the Order is of great use. The elementary knowledge of how to make a good fire is not shared by all; some people don't or won't know. Whilst most makers of appliances provide a card of instructions, the card gets lost, especially when the tenancy changes. Demonstration of how to make a fire before their very eyes is needed. Even then we have had the complaint " I don't care what you say, I don't like coke."

Large amounts of ash, clinker and flying dust gravely hamper the smoke abatement cause, whereas if we had the right fuel (and that means the right quantity and the right quality) at the right price, in the right appliance, together with the right education of the housewife, then indeed everything would be all right!

10. We will get nowhere without the support of public opinion, hence there is need now for the Society to undertake with unexampled vigour an educational campaign to preach the gospel of safe air. Dark smoke must go; the smoke haze or " smaze " which covers imperceptibly our industrial towns and deprives our people of sunshine and skyshine, must be swept away; the danger of smoky oil or " smoil " together with all the invisible gases, which play a part in fostering disease, should be dealt with in a new and drastic way. So we must give notice to quit to smoke, smog, smaze and smoil. Away with them all!

Conclusion.—The policy in present-day public health is not primarily punitive and prosecutory, it is advisory and educative. We must carry the public with us, though some offenders may have to be dealt with by invoking the force of the law. One must have understanding if not sympathy with some tenants who may blame their bronchitis on to coke fumes. You may argue until you are blue in the face with elderly asthmatics with these fixed ideas which were, incidentally, implanted by some of us medical men years ago. But skilful, gentle and continuous persuasion will in the end reap its reward. We shall have cleaner air, more sunlight and a healthier and happier people.

DOMESTIC FUEL FOR SMOKELESS HEATING

by

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The report of the Committee on Air Pollution postulated that if the air in industrial or heavily populated districts is to be cleansed adequately, smoke from the domestic chimney in those areas must be virtually eliminated. Ultimately domestic smoke should be eliminated or greatly reduced in other areas also, but priority must be given to the black areas.

The report further postulated that emission of domestic smoke could be reduced to an adequate extent only by the general use of smokeless fuels in domestic appliances. Experiments were conducted on open domestic fires designed for burning bituminous coal with reduced emission of smoke, but the committee could not recommend such fires for populous areas. It is claimed that closed stoves can be designed to burn bituminous coal with a much greater reduction in smoke emission than the open fire tested on behalf of the committee, but main objections to this solution are the unpopularity of the closed stove, that the conditions for low smoke emission must be carefully observed and that one of those conditions is the use of graded coal of a rather critical size; the domestic consumer is prone to disregard official instructions on operating appliances and the available amount of graded coal of the kind required would not go very far in meeting the requirements even of the black areas. The Committee came to the conclusion, which no subsequent information or considerations has weakened, that domestic heating in black areas must be effected by smokeless fuels.

The report envisaged permissive legislation. The local authority can determine, subject to agreement with the co-ordinating Ministry, that any given district shall be declared a smokeless zone or smoke-control area. Some misunderstanding has arisen on this nomenclature. The committee envisaged that the domestic consumer should be treated exactly the same in each area, in that he would be prohibited from using solid fuel containing more than 20 per cent. volatile matter. It would be very difficult administratively to do otherwise. Section 109(i) had appeared at first sight to some people to differentiate between the treatment of domestic consumers in the two types of area, but this is illusory. The distinction in nomenclature was drawn solely on the ground that it would be useful to retain the term " smokeless zone," but the designation " smokeless " would be inappropriate in any area containing industrial chimneys. A smoke-control area is what would otherwise be a " smokeless zone " were it not that it contains coal-using industries which, as postulated in Sections 24 and 96 of the Beaver Report, cannot be completely smokeless, unless they too use smokeless fuels. There cannot be enough smokeless fuel to make prohibition of industrial smoke practicable.

Legislation dealing with domestic smoke must be permissive and this carries with it the corollary that those to whom the Clean Air Act is applied must be satisfied with the new arrangements for heating their homes. The widest possible choice must be per-

mitted in appliances and in fuels; there will be an increasing number of householders who prefer gas, electricity or oil to solid fuel. (On grounds of national policy the use of electricity for domestic heat is inadvisable over the next half century). Nevertheless, although the use of the refined fuels is likely to become increasingly popular as the general standard of living rises and people seek to save domestic labour, the committee visualize that for economic and other reasons the main bulk of domestic heating, and particularly space heating, will be taken by solid fuel for many years to come. Moreover, the preference for the open fire was so generally emphasi ed that undoubtedly a high proportion—80 per cent. is suggested—of the smokeless fuels must be of open-fire quality.

In seeking supplies of smokeless fuel the Committee had a purely practical problem that demanded a practical solution in terms of fuel that could be made available in adequate quantity and of suitable quality. It was necessary to visualize the replacement in black areas over the next ten years or so of 19 million tons of bituminous coal. Reliance must be placed therefore on known and established fuels and known and established processes. We could not bank on the possibility of producing substantial tonnages of new fuels by processes not yet in commercial operation.

The result of our examination of the problem of providing a smokeless replacement for the 19 million tons of bituminous house coal used in the black areas is given in Appendix XI of the Report. This exercise indicated what could be done by making use of known techniques and processes thoroughly well tried and showed that the problem could be solved if the National Coal Board and the Gas Council in particular, and all the fuel industries in general, would co-operate to solve it. Our solution would inevitably disturb some existing arrangements, but such disturbance would not provide any insuperable problems. We insisted (Section 77) " that clean air should be the declared national policy and that such should be recognized both by the Government and by the nationalized fuel industries as an essential element in fuel policy in the future." The National Coal Board, for one, is evidently looking for such a lead since their 1954 Report contains this statement: " The Board are in sympathy with the object of reducing air pollution as far and as fast as possible and consider that the proposals of the Beaver Committee are generally sound. It is ultimately for H.M. Government to determine, in the light of national fuel policy, what part the Board and the other fuel industries should play in the attainment of this objective."

The pattern of fuel utilization laid down in Appendix XI of the Beaver Report is not to be considered as unalterable. It is intended as a practical demonstration, based on the evidence of the fuel industries themselves and on that of many organizations and individuals, that there exists at least one pattern upon which the required fuel can be made available during the next 10 to 15 years, and at a rate of increase that would be reasonable.

The overall picture presented in Appendix XI of the Report is given on the next page.

On this pattern, it would be necessary for the industries concerned to carbonize an additional 10 million tons of coal a year, and this would give rise to some 800 million therms of gas for which a use must be found. We have suggested that 360 million therms would be used to replace house coal for water-heating, bedroom and other intermittent heating, and short-period space heating, the remainder being used by industry. The gas industry has accepted the view that the main task of providing the fuel will devolve upon it.

Some observers, looking at the undoubtedly grave coal situation have doubted whether the additional 10 million tons of coal can be made available for carbonization. There is

	Coal replaced	
	Closed stoves *m. tons*	*Open fires* *m. tons*
Coal to be replaced	3.80	15.20
Replacement (in terms of coal replaced) by:		
Anthracite and smokeless coals yielding less than 20% V.M.	2.53	—
" Hard " coke (oven coke)	0.75	1.43
Gas coke transferred from other users	0.52	3.75
Electricity	—	1.38
Gas coke, new production	—	5.00
Gas, new production	—	3.64
	3.80	15.20

an adequate reply to this scepticism. In the first place, the coal needed is not *additional* to present production but is purely a replacement in that coal now burnt would be carbonized. Since the products of carbonization can be used with much higher efficiency in domestic appliances than the coal now burnt on the older forms of coal-burning grate, a substantial economy in coal should be achieved.

The major consideration is the alleged shortage of carbonization coal. We have to provide enough good metallurgical coke for expansion of the steel industry and in addition nearly 40 million tons of coal for the production of gas and coke for domestic heating and other purposes. Fortunately the lower-rank coking and gas coals produce more reactive coke, coke better suited for domestic purposes than the first-quality coking coals requedir for making metallurgical coke. Sources of the additional 10 million tons of carbonization coal are as follows:

(1) More than half of the large coal now used in this country consists of cokeable coal and a large proportion of this is of types 500 and 600, peculiarly suited for carbonization.

(2) The combined effect of replacing domestic coal under the clean air programme and steam locomotives under the railways reorganization programme will be that the present uses for large coal will disappear within a period of 10 to 15 years. The whole of the additional 10 million tons of carbonizable coal needed for the clean air programme could be obtained from this source alone.

(3) Millions of tons of cokeable coal are now burnt under boilers or used in similar ways for which non-coking coal or oil would be an adequate, indeed advantageous, replacement thus releasing the coal for carbonization.

(4) Blending coking coals with weakly-coking coals is a recognized method of making a reactive coke.

The gas industry is examining the extent to which more coke could be made available by such means as the use of coal in water-gas plants, the replacement of water gas by oil gas, and the replacement of coke by non-coking coal in producers for firing gas retorts, while renewed interest is being shown in the manufacture of reactive domestic coke by carbonizing doubles or larger coal in continuous vertical retorts.

It is not sufficient to produce enough coke. The coke produced

must behave in a " lively " manner on the fire and have the necessary composition and structure to give it that property. The carbonizing industries must produce coke of the right quality if the consumer is to be satisfied with the conversion. Upon the reactivity of the coke will depend whether or not it is easy to ignite, whether after the fire has burned low it can be revived quickly and whether a comparatively small fire can be sustained. It is essential that all old coal-burning appliances should be replaced by modern appliances. Given modern appliances there is no difficulty in making solid smokeless fuel of the right quality; the problem before the carbonizing industries is to determine the best of several alternative methods of doing this.

The problems in the supply of solid smokeless fuel can be summarized under the following heads:

(1) Sufficient fuel for open fires and closed stoves must be made available at the rate at which smokeless zones and smoke-control areas are instituted, the full " black area " total of replacement for 19 million tons of coal being completed in 10-15 years.

(2) The solid smokeless fuel supplied to these zones must be of sufficient reactivity to give satisfaction on the open fire; this applies to coke made available from existing sources as well as to new production.

(3) The ash content of the fuel must be reasonably low; this will entail the provision of more coal-cleaning facilities at the pits.

(4) Additional carbonizing capacity must be provided at a cost which " would be counted in tens of millions of pounds and not in hundreds of millions " (*c.f.* Henry F. Jones, *Financial Times*, 24th May, 1955).

From this discussion two points emerge which are here emphasized particularly:

(1) The Beaver Committee's estimates were based on the minimum cost at which existing appliances could be replaced by solid fuel appliances burning coke. The increasing cost and scarcity of coal and the resulting heavy cost of coal imports are now a strong argument for facing the additional capital costs entailed in installing free-standing appliances of higher efficiency in order to save domestic fuel. The new appliances might well be tenants' fixtures and this meeting could usefully discuss the methods by which purchase of modern appliances by the householder can be stimulated and financed.

(2) The rate of institution of smokeless zones and smoke-control areas must be co-ordinated with the supply of suitable fuel. The conditions of last winter led to widespread complaints of coke shortage. This was generally due to a back-log of orders far in excess of the capacity of the staffs and vehicles of the distributive trade. All solid fuel was affected by the abnormal conditions, but the experience of the few months immediately following the issue of the Beaver Report emphasized the great importance of administration in organizing a smokeless zone.

INDUSTRIAL ASPECTS OF THE BEAVER REPORT AND CLEAN AIR BILL

by

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This paper has been prepared after only preliminary consideration of the Clean Air Bill and hence the comments on it can only be tentative; there will be vigorous discussion on it in Parliament before it becomes a Clean Air Act.

The references to industry in the Beaver Report can be divided into four main headings:

(1) Smoke.

(2) Grit and dust.

(3) Sulphur oxides from combustion.

(4) Aerial effluents from scheduled and other special processes.

The Bill specifically deals with (1), (2) and (4), and follows the recommendations of the report.

Railway steam engines and ships' boilers are not to be "scheduled" under (4), although the problems of smoke emission from them are difficult of solution.

Definition and Measurement of Dark Smoke

The Bill defines dark smoke for the present as that which is darker than No. 2 Ringelmann, but leaves it open to be argued in court that a smoke is dark even if there has been no actual comparison with the Ringelmann Chart. This will cover the case of a smoke which is not grey, the colour of the Ringelmann Chart shades. Many physicists have criticized the Beaver Committee for sticking to the Ringelmann Chart as the basis of measurement, but none have been able to put forward an alternative means of estimation of the darkness of smoke as viewed from outside the chimney, which is what the smoke inspector has to do. To cover the future, the Minister may make a regulation changing from the Ringelmann to any improved method which is developed.

The Report suggests that a defendant in proceedings should be allowed to produce in his defence records of the density and duration of discharge of the smoke as recorded by an automatic smoke recording instrument. The Bill omits any reference to this suggestion, but I hope that the proposal will be inserted by Parliament because it is intended to encourage continuous observation of smoke at the firing floor, thereby assisting the operators to minimize periods of smoke emission and enabling the management to keep a quantitative record of plant performance. If the only objection to admitting evidence from recorders is legal and administrative, the drafters of the law should be challenged to overcome them.

The Report recommended that the British Standards Institution should prepare a specification for smoke density meters and alarms. These meters are of the type which, by means of light sensitive cells, measure the obscuration by smoke of a light beam shining across the smoke in a flue or chimney. They do not measure the same physical properties of the smoke as the eye does when comparing the smoke issuing from the top of a chimney with a Ringelmann Chart, because in the external observation not only is light from the sky obscured, but light from the front of the smoke is reflected back to the observer. The Report states that there was a satisfactory correlation between ex-

ternal and internal observations on one plant. It regards the smoke density instrument as an important aid to the men operating a furnace which is liable to produce dark smoke. The British Standards Institution has therefore formed a Committee as requested to standardize smoke density alarms and recorders and on this Committee not only are there instrument manufacturers, but also representatives from industry, including engineers in charge of operations, and the two fuel research organizations, namely the Fuel Research Station and the British Coal Utilization Research Association. This Committee has made good progress in the preparation of a specification for an inexpensive instrument which will give a visual or audible alarm when the smoke is above a predetermined set limit of density: coupled with the instrument there can be a clock which records the total time each day or shift during which the smoke is above the set limit. Instructions will be given for setting the alarm against the density of smoke as viewed externally and compared with the Ringelmann Chart. Consequently, each instrument can be made to give an alarm when the smoke is approaching the density at which the smoke inspector would take action. A draft of the specification for the alarm instrument, though not that of a recording instrument, was sent to industry for comment in August.

Necessity for Occasional Emissions of Smoke

In the Bill, dark smoke is prohibited, with certain exceptions, from all processes. Apart from processes to be scheduled under the Alkali Act, the exceptions are to allow for short periods of dark smoke emission when necessary operations are carried out in a furnace to maintain its operating and thermal efficiency. These necessary operations include the raking and slicing of fires in smaller plants and are necessary even when mechanical firing equipment is provided, though the frequency does depend on the design of the mechanical firing equipment and grate and on the suitability of the fuel. When a burning mass of coal is disturbed vigorously, there is a sudden increased evolution of volatile matter and there may not be sufficient excess air present at the fuel bed, or the mixing arrangements of the air with the flames in the furnace may be insufficient to burn it completely, with the result that the flue gases carry in them very finely divided carbon and tar: once formed, these are difficult to burn, even when there is sufficient air, and so smoke is emitted from the chimney. Larger boilers are of the water tube type and it is seldom necessary to slice the fires in their furnaces, but it is necessary to remove deposits of ash from the tube surfaces. This is usually done by steam jets and the operation is known as sootblowing. When jets of steam are directed against the tubes which are being licked by the flames, the flames are quenched and some dark smoke is formed. Sootblowing also gives extra work to the fans drawing the gases from the furnace and it sometimes happens that the fans cannot pull sufficient air into the furnace during the period of sootblowing. The Report, in making reference to these operations, says " We think it would be proper to permit a total upper limit of six minutes of dark smoke in any period of four hours but that no single burst of dark smoke should last more than three minutes. We recommend that the Government should have power to make regulations to prescribe or amend the permissible limits for temporary emissions. . . ." It will be seen that the Report gets away from the old idea of one or two minutes emission of black smoke in a period of half an hour. The period of four hours is based on the industrial period of a shift of eight hours and the belief that sootblowing is seldom carried out more than once a shift. I think that smoke inspectors will soon find ways and means of overcoming the apparent difficulty that they will be expected to observe a chimney for four hours

continuously to check that it is not infringing the regulations, but they will not be able to observe what happens at night. For industrialists anxious to abide by the regulations, there will sometimes be difficulties when several furnaces are connected to one chimney. With very large boilers the gas volumes are so large that dark smoke from one point of the furnace is adequately diluted by flue gases from another furnace and, alternatively, when there are two well run small boilers arrangements can be made to sootblow each only once a shift; but techniques may have to be developed for operating within the proposed regulation when there are only three or four boilers.

The Bill very wisely gives the Minister power to specify the periods of time allowed for these necessary operations; different periods may be allowed for different types of plant and the periods may be varied in the light of experience.

Codes of Good Practice for Smoke Emission

The Report states that it is usually possible, given good practice, to make less smoke than the quantity mentioned above and it has recommended that the British Standards Institution should prepare codes of practice indicating the extent to which smoke can be reduced by good practice and the means of securing such reductions. This Committee has been formed and I have the honour to be its Chairman. The Committee is already at work making measurements with automatic smoke recorders of the frequency, duration and density of dark smoke during the operations of sootblowing and attention to fires. The measurements are being made at works which have modern plant and are ably operated by their men. The records are taken continuously over periods of several weeks and the men do not necessarily know that any test is on, and consequently measurements are being taken under normal good commercial operating conditions. Care is being taken to choose plants receiving coal which is of a quality recommended or acceptable to the designers of the grates and furnaces, since it is obvious that low figures might not be obtainable if the coal was of a quality for which the plant was not designed. The B.S.I. Committee is composed of engineers from industry and manufacturers of boilers and firing equipment, together with a very hard working engineer from the Ministry of Fuel and Power, who is making most of the detailed arrangements. Instrument manufacturers have lent the necessary special recording instruments to enable the measurements to be made and the Fuel Research Station has assisted in their calibration on a uniform basis. And, most important, the managements of numerous works have given facilities for surveys of their boiler plants and the taking of measurements at selected plants. It will be seen that the British Standards Committee has embarked on an investigation which will result in the publication of " bogey figures " for the operation of a number of classes of plant and it is hoped that industrial engineers will be stimulated by these figures to operate their plants as well or even better. It will be many months, however, before these investigations can be completed, since there are many classes of firing equipment in boiler and other furnaces on which measurements will be made. It is doubtful whether the B.S. Committee will be able to make effective measurements of the duration of dark smoke emission when a furnace is lit up from cold since the opportunities for making such measurements are infrequent. The Bill, however, states that all practicable steps must be taken to prevent or minimi e the emission of dark smoke when lighting up from cold and it appears that the technical advisers to the Ministry are satisfied that furnaces which are shut down temporarily overnight can be brought on work again without serious smoke emission; this I believe to be true with many designs of modern plant, provided the right steps are taken to seal up the furnace against

heat losses when it is temporarily shut down.

In the meantime, it is necessary that manufacturers of firing equipment for all classes of furnace should work hard to produce less expensive mechanical stokers which do all and more than the men do when firing manually, which move the fire forward in such a way that slicing and raking of fires are not necessary, which give a quick response to sudden demands for increased load, which have a good " turn down ratio " and which can be shut down overnight by means of suitable dampers and restarted in the morning without making smoke. In addition, and of equal importance, the equipment must be capable of burning a wider range of fuels. The Report says " We are satisfied that coal quality by itself is rarely the cause of excessive smoke " and the challenge to equipment manufacturers is to replace the word " rarely " in that statement by the word " never."

Grit and Dust

The Report states that it is difficult to lay down maximum tolerable limits for grit and dust emissions and that they must be related to the size of the plant. It emphasizes in Appendix IV that efficiency of collection is less important than the total weight of escape per day and the size grading of the escaping grit and dust (it suggests for simplicity that grit is material greater than 200 B.S. sieve size, equal to 0.076 millimetres or 76 microns). The Bill states that " any practicable means " are to be used for minimizing dust and grit emission from all plants. It also states that all plants burning pulverized fuel and any plant burning, per chimney, solid fuel at a rate of more than 10 tons an hour are to be provided with grit and dust arrestors which are approved by the Local Authority and that the plant is properly maintained and used. The Bill therefore states that the Local Authority may require a factory owner of these latter classes of plant to make and report to them measurements of grit and dust emitted from his chimneys. This is quite important since it is a criticism that many dust arrestors do not remain in tune or are badly run.

There is at present no simple standard method of measuring grit emission and because of this the Report asked that the British Standards Institution should prepare a simple specification on the subject. Like the others mentioned above, this Committee has also been hard at work during the spring and summer and is making good progress with a specification for measuring grit emissions, but even when this has been prepared in draft it will be necessary for it to be tried out thoroughly in practice before the method is published. It must be reali ed by those concerned with the administration of this part of any Clean Air Act that the measurement of dust concentration is difficult and may not be particularly accurate, but to my mind an error as great as 25 per cent., and on a small plant as great as 50 per cent., will be quite immaterial with the present state of knowledge of the way in which dust and grit from a chimney reach the ground in the surrounding neighbourhood.

It is to be expected that examination of the measurements of performance of grit and dust arrestors in service will enable industry to learn the weaknesses of existing arrestors and to obtain better and cheaper designs. I am sure that the measurements will lead to a demand on the manufacturers of dust arrestors for more effective but cheaper plant, but it is also important that combustion engineers should develop methods of burning solid fuel in a manner which produces less dust for the arrestors to collect.

Chimneys

Even when the discharge from a chimney is less than that of dark smoke in colour, is virtually free from grit and contains only a low concentration of fine dust, it can still be a nuisance to the inhabitants if the wind carries the smoke plume down to ground level before it is diluted

several hundred times. In Appendix VI the Report draws attention to the need for high chimneys to avoid the smoke being blown direct from the top of the chimney in eddies caused by adjacent high buildings and the need for securing thorough dilution of both the sulphur oxides and the dust. Wherever possible flue gases should be discharged from one instead of several chimneys attached to a plant, because the larger volume of hot flue gases from the single chimney are less quickly cooled by the wind and consequently rise further; as a result, they are more greatly diluted by the time they reach the ground. Appendix VI of the Report is highly technical but should be carefully studied.

Processes to be registered under the Alkali Act

As recommended by the Committee, the Bill proposes that the general dark smoke, dust and grit regulations which are to be administered by the Local Authorities should not apply to any works registered under the Alkali, etc. Works Regulations Act, 1906, and it gives power to the Minister to extend the list of these registered works. The Local Authority, with the consent of the Minister, may still take proceedings in respect of smoke. The Bill follows the advice tendered in the Report that those industrial processes in which it is known that there are special difficulties in minimizing the emission of smoke, dust and noxious gases and which have previously escaped control under the Public Health Act, 1936, or the Alkali Act, should be supervised by a Central Technical Inspectorate. These processes all cause some atmospheric pollution and it is not always the larger works in these processes that give the most trouble, partly because the largest works are of the more recent design. The advantage of this proposal is that, under the Alkali Act, plans for all new plants are carefully studied by a group of men who can, if necessary, consult the highest technical authorities in any country. Under the Alkali Act also the Inspectorate has power to check that a plant is operated correctly and therefore that the men are adequately trained in their duties, that the plant has the necessary indicating and recording instruments for its effective control and that the plant is properly maintained. The disadvantage of taking away from the Local Authorities the supervision of some plants which are borderline cases is far outweighed by the advantage which will accrue from having all difficult processes of a like kind under a central supervision. It cannot be too strongly emphasized that in plants which are or will be registered under the Alkali Act the worst of the atmospheric pollution from them arises from their design and that atmospheric pollution arising from faulty operation of a well-designed plant is infrequent and far less damaging, however serious it may appear at the instant of time when it occurs. The Society has advocated prior approval in the last ten years and the Bill institutes the most effective prior approval possible of these difficult processes. The Bill does not state what classes of process the Minister intends to include under the Alkali Act, but no doubt they will be those listed in the Report, with a few additions.

Conclusions

This review shows that industry has immediately accepted those recommendations of the Beaver Committee on which it could help at once, namely the preparation in the British Standards Institution of specifications which will help in the future control of pollution. The Bill has incorporated the important recommendations of the Report and it will remain for Parliament to add to the Act any other points made in the Report which it feels should be incorporated. The Bill as it stands has the merit of flexibility. All clauses in it only come into force on " appointed days " and many clauses delegate the formulation of detailed regulations to the Minister and he can issue and amend them in the light of experience.

RESEARCH

by

C. J. Regan, B.Sc., F.R.I.C.

Chairman Atmospheric Pollution Research Committee

The aspect of the report with which I have been asked to deal is the very important one of Research. The Committee devoted much time and attention to this both in relation to what had already been done and as to what further information was necessary in order to obtain a clear and complete picture—referring back to our terms of reference—of the "nature, causes and effects of air pollution" and thus to assess "the efficacy of present preventive measures; and to consider what further preventive measures are practicable. . . ."

The past history of research into the subject is, no doubt, so well known to members of this Society that it need be touched on only briefly. Probably the most important milestone on the road of progress was the Smoke Abatement Exhibition of 1912 which resulted in the setting up of a committee of investigation for co-ordinating a scheme of measurement of pollution. The Committee soon came under the auspices of the Meteorological Office but in 1945 the Atmospheric Pollution Research Committee, as it is called, became a committee of the Fuel Research Board, Department of Scientific and Industrial Research. This action logically connected prevention of air pollution with the important matter of fuel efficiency and economy. The executive and administrative work of the Committee was then centred at the Fuel Research Station under the control of the Director of Fuel Research, Dr. Parker, who, by his knowledge and enthusiasm for the cause of clean air has, since that time done so much to develop research into this most complex problem.

The statistical and other information available over the years from the results of the regular surveys of air pollution and research under the auspices of the Atmospheric Pollution Research Committee were invaluable in the deliberations of the Beaver Committee. For some districts figures were available for forty years and in recent times the number of observation stations has increased greatly.

Coming to the Beaver Report itself, the principal mentions of research occur in paragraphs 18, 56 and 119, and in Appendix 3 which is entitled "Research and Development." It may be helpful to summarize some of the more important aspects.

1. **Measurement**

There are now in operation 1,664 instruments for measuring the various constituents of air pollution. In general the picture produced from the results of these (most of which operate on a monthly basis) is reasonably complete with the one important reservation that more frequent and intensified measurements are desirable in the London area and in other areas susceptible to severe smog. So far as London is concerned, by the co operation of the Metropolitan Boroughs and the London County Council, steps have been taken to meet this requirement by the installation of many more daily observation stations, and, in some cases, by instruments which will give even shorter period records should a dense smog occur such as that of December, 1952.

It is to be hoped that a similar frequency of observation will be arranged for other densely populated areas.

It seems desirable from the medical investigations that special consideration should be given to sulphuric acid mist and attention is being devoted to this matter which is somewhat difficult from the analytical aspect.

The development of automatic measuring instruments is most desirable to minimize the time necessary for visiting the observation stations and performing analytical operations. The problem is not easy and the cost of such apparatus introduces another difficulty though work is proceeding.

2. Effects of Pollution

The many aspects of this are being investigated intensively both in this country and in the United States, but there is still a great deal to be learnt in relation to the effects on materials, agriculture and the human body. As regards the last-mentioned, the Medical Research Council has set up a Special Committee on Atmospheric Pollution and this, through a series of working parties, has initiated a programme of research which should, in due course, yield most important results. There is, at present, a great lack of knowledge in this field regarding the ill-effects of the many constituents in air pollution and their inter-relationships, for example, combinations of sulphur dioxide and smoke. It is not a purely medical or pathological matter and it is important that medical, chemical and biochemical, and physical research on this subject should be closely co-ordinated. Probably the biochemistry of the human respiratory system is the crux of the problem.

Other aspects of research into the effects of air pollution are the studies that must be continued of morbidity and mortality data in relation to meteorological and pollution records. Also the surveys of hospital patients, with and without respiratory diseases, to investigate the relative roles of various social and environmental factors.

The effects of air pollution on structural materials have been under investigation for many years especially by the British Iron and Steel Research Association and the Building Research Station, D.S.I.R., and by the Ministry of Agriculture and Fisheries in regard to agriculture. It would seem that, particularly in the latter field, there is still need for much further research.

3. Reduction of Pollution

Whilst there is even now sufficient knowledge available to achieve a very considerable degree of prevention of air pollution if the various necessary actions are taken, there is still need for a large research programme to solve, or attempt to solve, some very difficult outstanding problems.

It seems convenient to consider these seriatim in relation to the various forms of pollution:

(*a*) *Smoke:* This can be divided into its two sources, (1) industrial, and (2) domestic.

(1) *Industrial:* If the steps recommended in the Beaver Report are universally adopted smoke from this source can be reduced to a minimum in a few years and little further fundamental research seems to be required though applied research on the improvement of appliances would be helpful from the efficiency aspect; for example, that proceeding at the British Coal Utilization Research Association on chain grates.

(2) *Domestic:* Here again, by the use of suitable smokeless fuels in suitable appliances smoke can be eliminated though the changeover will take a period of ten years or so for the so-called " black areas " and it will be longer still before the whole country can be equipped for smokeless operation; this is, of course, because of the necessity for providing suitable appliances and sufficient smokeless fuel.

In the meantime useful research can be done on the design of more efficient and economical domestic appliances which will burn ordinary bituminous coal with less smoke and, if possible, smokelessly; also on better methods of installation. The most

important necessity, however, is to increase the supply of smokeless fuels, and to do this investigation is necessary into the production of solid smokeless fuels from other types of coal than those now used in gas and coke manufacture. The latter type is now in short supply and seems likely to become more so. The possible use of other coals has been, and is being, investigated both at the Fuel Research Station and also by the various Gas Boards; it is sincerely to be hoped that methods will be developed for utilizing a much wider range of coals for the production of smokeless fuels.

(*b*) *Grit and Dust:* This is derived almost entirely from industrial sources, and it is probable that this type of pollution is the one which causes more nuisance and annoyance in areas subject to it than does any other. In general it can be said that methods of prevention are known, but there is an urgent need for the development of cheaper and more efficient dust arresting equipment for both large and small plants, particularly for dealing with the finer particles of dust; also for devising techniques and instruments, as simple and cheap as possible, for the monitoring of grit and dust emissions. Work on the latter problem has been proceeding for some time at the Fuel Research Station.

(*c*) *Sulphur:* As regards reduction, this is undoubtedly the most difficult pollutant; for the concentration of sulphur oxides in chimney emissions is extremely small especially in the case of domestic appliances. Moreover, the suggestion, on the basis of "prevention is better than cure," that the sulphur should be removed from the coal at the colliery by washing can achieve only a very partial solution; for much of the sulphur is inherent in the coal structure and thus cannot be removed by washing as can the portion in the adventitious matter associated with the coal as mined. Nevertheless, washing does effect some reduction of sulphur and its general adoption is desirable, as is also further research to ensure that the most efficient and effective removal shall be achieved.

The possibility of preventing the release of the sulphur in the fuel into the flue gases on burning has been considered. Normally only a very small proportion is retained in the ash and the increasing of this proportion poses a very difficult problem. Research is, however, being devoted to the subject.

Washing of flue gases for the removal of sulphur oxides seems on economic grounds to be practicable only in the very largest coal-burning installations, i.e. electricity generating stations. It operates at present at Battersea and Bankside in London. Much work has been done at the Fuel Research Station on another process (Fulham–Simon Carves), using waste gas liquor as the washing liquid; this has the advantage of recovering the sulphur as ammonium sulphate and elemental sulphur. The pilot plant test has been most promising and the Central Electricity Authority is now co-operating by constructing a large plant for trial at one of its stations. Further research on this problem seems to be one of the most urgent necessities.

It has been claimed in some quarters that, by using very tall chimneys, the sulphur oxides are sufficiently dispersed into the upper atmosphere to render them harmless. There is little real knowledge on this subject the study of which is a matter of extreme difficulty having regard to variations in meteorological conditions; but it is definitely one on which research is required. Moreover the ultimate fate of the sulphur compounds is unknown for the measurements so far made only account for a relatively small proportion of it.

(*d*) *Other Pollutants:* Motor vehicles have increased so greatly in number that exhausts from them contribute considerably to air pollution. More work on the extent of this and the nature of the exhaust gases is necessary; also on the effects, particularly from the human aspect, of the con-

stituents, for example carbon monoxide, aldehydes, oxides of nitrogen, etc. More fundamental, perhaps, is the problem of prevention of this form of pollution especially the possibility of attaining complete combustion whereby the organic fuel used is completely converted to harmless carbon dioxide and water. Research on this is proceeding.

The large scale plan of the British Transport Commission for the electrification and dieselisation of railways will eventually solve the problem of railway smoke; but it must be borne in mind that the diesels will add to the pollution mentioned in the previous paragraph and so will need further attention.

Emissions of acid and other noxious fumes from chemical works, etc. are under the control of the Alkali Inspectorate and research into some of these is a continuing procedure. For example, the programme of the Fuel Research Station includes extramural work at Sheffield University on methods of reducing smoke emission from certain types of steel furnace.

In the short space available to me I have been able to deal only very superficially and in general terms with this problem of Research. Much useful work is proceeding both in this country and abroad, particularly in the United States, and it seems essential that the closest possible system of liaison should be maintained between the vast number of workers in this field of investigation.

The Beaver Committee attached great importance to the need for further research on the problem of air pollution some of the aspects of which I have mentioned. Much has been accomplished in this country in the past, particularly under the auspices of the Fuel Research Station, Department of Scientific and Industrial Research and the Atmospheric Pollution Research Committee but there is still a need for a programme of investigations covering a very wide field.

Discussion

The Chairman, **Dr. R. Lessing,** said in his opening remarks that that afternoon's session of the Conference had the opportunity of hearing from a few members of the Beaver Committee some of the facts and views on which the report was based. During the last 150 years many Government Committees had deliberated and advised on the smoke nuisance and its abatement, but none of their reports had met with such general approval and commendation as that of the Beaver Committee. It had roused public opinion to the recognition that at long last active steps must be taken substantially to lessen, if not abolish, the evil of air pollution. What was more, it had impelled H.M. Government to adopt a " clean air policy " and to implement that policy by laying the Clean Air Bill before Parliament within eight months of the issue of the report.

It was fair to say that all points in the report which had been criticized in the intervening months—and they were mainly points of detail and not of principle—had been discussed again and again by the Committee, in its 133 meetings, among its members and with interested parties and, although some were necessarily of a controversial kind, the Committee's findings and recommendations were unanimous.

It was gratifying to note that most of those recommendations were embodied in the Bill. There were certain omissions and modifications, no doubt dictated by governmental expediency. Some of the members would have liked a provision included for the establishment of a Clean Air Council. Dr. Lessing also said that one missed a clause expressly dealing with the emission of sulphur oxides instead of leaving it casually implied in the control of noxious gases. No doubt there would be amendments as a result of the debates in Parliament. However, by and large the Bill, when enacted, would go a long way towards the 80 per cent. abatement of the evil as realistically envisaged by the Beaver Committee.

The major effect which one must expect from the Clean Air Act was the realization by the public, householders and industrial managements alike, that there was something—and indeed much—to be gained in complying with its provisions. As shown in Appendix I of the Beaver Report the damage done by air pollution had been assessed, by the closest estimate yet made, at £250 million per annum, not counting the waste of fuel amounting to £25 to £50 million. It was unthinkable that the ultimate benefit of a lessening of that large loss, however intangible, should not be felt by the individual.

One might therefore hope that there would not be any need to apply the punitive clauses of the Bill except in relatively rare cases. That, after all, might be wishful thinking, but the citizens of this country were law-abiding and did not, as one might gather from the sensational press, comprise a large section composed of criminals. The offenders would know that there was a rod in pickle for them and would learn to amend their ways.

The new Act would remain a dead letter if it were not supported by an intensive and persistent campaign for the enlightenment of all in the correct use of fuel and the appliances in which it was burned, and that was work in which the Society would help. Dr. Lessing said that ever since he joined in 1908 the Council of the London Coal Smoke Abatement Society, he had pressed for the spreading of technical knowledge as the most hopeful line of attack on the problem.

Today, we had plenty of such knowledge which awaited application forthwith on a wide scale. But there were also many questions still unsolved in the provision of the right fuels, the appropriate methods of combustion, the impact of meteorological conditions and, not least, the effect of pollution on health. Those questions could only be solved by more, and more intensive, research, the funds for which would be a good investment, repayable out of the savings in the cost now incurred by the immense damage caused.

Sir Roger Duncalfe, opening the discussion, said:

I am very happy, as a new member of the Society, to be participating in this splendidly organized and most ably conducted conference, and it is a privilege to be asked as Deputy Chairman of the Beaver Committee to open this debate. I would like to say how sensible I am of the great value to our community of the work done by the Society over the years. The awakening of public opinion which has resulted from that work has been one

of the main reasons why we have the Bill before Parliament today.

The five papers before you were presented by five good colleagues with whom I served a sentence of eighteen months' hard labour. It was hard and unremitting, but interesting and rewarding work which we shared together. At the end of it we developed, as I think has been said, a remarkable unanimity. If there were any major differences of opinion between us, those have long since been thrashed out in most strenuous debate. You therefore will not expect me to be critical of my colleagues' views, because they are mine. Their papers are clear, concise and to the point. They are much more knowledgeable in their respective fields than I am. There are enough points in those five papers already to occupy discussion for the rest of the time available, so that I must be as brief as I can be.

I would like, to start, to refer to the opening paragraph in Mr. Graham's paper. He says " the dominant need is the effective translation of words into action. In considering action to be taken, however, whilst guarding against platitudes, doubtless it will also be recognized that measures to be urged shall neither fall short of obligations to society nor fail by attempting to exceed the prevailing bounds of practicability which stimulated research must expand." That, in my opinion, is a very true statement. In other words, he says that we must be economic in words, forceful in action; we must devote our thoughts and even direct and limit our words to those necessary to assist action along practical lines. I will try, in my few words, to do that.

Public opinion has been very kind to the Beaver Report. We have all been much encouraged by it, and Parliament, which follows public opinion in the main, and with the powerful aid of Gerald Nabarro's Private Bill, now has before it a Clean Air Bill backed by both parties. There has been a good deal of criticism about this Bill, but a Parliamentary Bill is but the legislative framework within which administrative action must proceed. Its terms must be precise—in a matter of this kind, a number of its provisions must be in the nature of enabling clauses as knowledge is moving forward—and there must also of necessity be certain saving clauses. You cannot escape the need for saving clauses. I agree that they should always be looked at very critically. The publication of a Bill always tends to sharpen discussion and the tempo increases as the Bill moves on its various stages through the House.

I want to reply if I may to four criticisms which I have heard or read, or which have been mentioned to me personally or raised at this meeting. The first is that the Beaver Committee dealt only partially with the whole problem of air pollution. The second is that one at least of its recommendations is archaic. The third is that the Beaver Report was too much influenced by industrial opinion, and the fourth is that the Bill has been even more influenced by industrial opinion and contains too many escape clauses.

Now on the first point—a partial approach. Of course our report did not pose the final solution of all the very complicated problems involved in air pollution. If it had attempted to do so you would not have had our report last year, and you certainly would not have a Clean Air Bill before you now. The Beaver Committee, may I say, was a very determined body of men. We were fortunate enough, as our Chairman today has said, to have had a very clear-sighted Chairman. We had read a number of reports, stretching over many years. We had studied a good deal of piecemeal legislation. We had reviewed administration, local and otherwise. We were appointed following a great calamity. The enormous toll which air pollution had taken of national treasure and life and health and happiness had been brought home to us, and we were determined that our report should be of such a nature as would force action in our day to attack this evil which lay over our land. To secure that objective we were forced to adopt an attitude of intense realism. Had we not done so, it would have been fatally easy in so difficult and complicated a field, which embraced so much of the unknown, to allow our thinking to land us in a fog or smog in which we lost our sense of direction and purpose, and therefore we would not be able to direct the thought of others. The basis on which we proceeded was to set out as simply, concisely and strongly as we could, facts which emerged from our investigation and the practical steps we were satisfied could be taken to abate 80 per cent. of the smoke nuisance, including grit and dust and most of the other solid filth which gets into the air we breathe. We felt sure of this, and we felt that it would be a good start, anyway, and in itself a blessing to our land.

We had to consider not only the legal provisions, but the administration of the law, in great detail. We had to apply an equal realism to the detail as we had to the broad concept. Our proposals had to recognize the need for prompt action, and also the anticipated advance of knowledge and practice—to deal with the latter we recommended wide enabling powers to the Minister. Where knowledge was insufficient for definite proposals, we admitted it frankly, and made suggestions as to what further knowledge was needed, how it might be obtained and the research and development work needed, and in that connection I think Dr. Regan would agree that, when he talks about research, he talks about research and development. I hope you will agree we were wise to limit our attack within the terms of our report. Action has at least followed our report, which I submit was forceful, concise and reasonably simple to understand, and its arguments were reasonably supported by the appendices for those who cared to read them.

Our main thinking was in three categories, and I must just make this point, because something follows. We were completely satisfied that industry, well equipped and properly manned, need not emit more than a slight haze of smoke in the ordinary processes of steam raising, and therefore we proposed to make dark smoke from such chimneys an offence except for the necessary specified brief periods. We placed the administration of the law in this respect fairly and squarely on the shoulders of the local authorities. We felt that our proposals clarified the law and greatly strengthened their powers to deal with the recalcitrant, and thus would remove many of the frustrations which were disheartening to many authorities and the officials who served them with such devotion—a difficult and often a rather thankless task. Our sense of the size of the job we put on the local authorities was as profound as our belief for the need in the strengthening of administration which was required if this smoke evil was to be conquered. Thus, local authorities have it in their hands, and industry came first on our list.

Secondly, we felt if we were to secure clean air it was necessary to deal with domestic smoke. You cannot deal with this problem of smoke abatement unless you deal with domestic smoke as well as industrial smoke. Industrial smoke should come first. Our ban on dark smoke would not deal with the domestic problem, and we developed the idea of smoke control areas which could be wider than the old idea of smokeless zones. Here again administration was placed fairly and squarely on the local authorities, both as regards the declaration of the areas, the provision of approved appliances and types of fuel to be used, also the timing; all subject to the confirmation of the Minister. There seemed yesterday some regret that the Bill did not mention the old smokeless zones. I think there is a misconception there in some minds. I say that because, as I see it, the power is in the hands of the local authorities, subject to confirmation of the Minister, that can at their own discretion deal with local circumstances and make the area as smokeless as circumstances will permit. Here again, an immense administrative task which we appreciated, placed upon the shoulders of the local authorities.

Now we come to the third category of our work, the special cases. Many local authorities, I believe, feel that those should have been left in their hands. I do not agree with them. If we are to progress they must be subject to constant challenge. That is the point; we must make progress in this respect as rapidly as we can, and the means are not so important as the result, provided the constant challenge is forthcoming. You will know that in our report we expressed our views strongly that those industries which had had a large umbrella held over them by Clause 109 of the Public Health Act, 1936, should be taken from under that umbrella, but that much research and development work was needed and there must be a central and co-ordinated attack upon their problems. It was our own thinking and not other representations which forced us reluctantly to the conclusion that the only sensible approach was to place this heavy problem in the hands of a Central Inspectorate, with wide powers. To leave this highly technical problem in the hands of local authorities would tend, in my view, to confuse the issue and reduce the true power of the challenge for better methods. I feel pretty sure that we were right and that licensing and control by a central authority is necessary.

On the second point, about archaic methods, I refer to the correspondence in the *Manchester Guardian* on the Ringelmann chart. As Mr. Nabarro said yesterday, you have not only to have the law, but you have to have the policeman, and the best policeman we know in this respect for inspecting the chimney from

outside at the present time is the Ringelmann chart, which has done great work in America. Nobody else has told us of anything better than that policeman. We are doing much more than this, as Mr. Nonhebel said. We are very busy on the development of the instruments which we and you feel are necessary in the boiler-house, and the British Standards Institution, of which I have the honour to be President, has got down to that matter with speed and determination.

Now on the dead hand of industry. I am an industrialist and therefore to some extent suspect in certain quarters, but I was also Deputy Chairman of the Beaver Committee, and that job came first. I made it quite clear to everybody with whom I was in contact in industry, that I spoke for Beaver and not for industry, and I never acted or spoke as industry's spokesman. I yield to no man, ladies and gentlemen, in my determination to do my best to ensure that to the maximum extent practicable, men and women in my day (and I am seventy) shall be able to breathe pure air and enjoy God's sunshine.

I must be fair to industry. To the best of my knowledge, organized industry through the F.B.I. has been, throughout, constructive in its approach. I do not blame them for being practical—that is a sensible thing to be, as long as you are not obstructive, and all I can say is that at all times—and as I say, Beaver and his Committee were a very determined body of men—at all times they were very ready to be cross-examined and tested upon any point. It is just not true that the Beaver Committee was cramped or unduly influenced by the industrial point of view. The Bill, of course, is not the work of the Beaver Committee, but here again I strongly question the statement which Mr. Nabarro made yesterday that the F.B.I. is written large over it. It follows the Beaver recommendations fairly closely, you know. I have said it has had certain saving clauses introduced. I have said a word about the reasons, and I think they want rather carefully watching. On one of them the Beaver Committee's view was that if care were exercised in the choice of plant and skill of operation, no more than a light haze of smoke need be emitted with any normal type of fuel and 1.3(*c*) of the Bill was not included as one of our recommendations, but I would suggest that you study very carefully the wording of the sub-clause. It seems to me that only under very exceptional circumstances could or should that sub-clause be invoked, and unless this were so, I think the door would be too wide. Yesterday, on another point I would like to make, we heard references to seven years exemption. The references are, of course, Clause 22 of the Bill and para. 93 of the Beaver Report. I think there is a widespread misconception on this point. Some people think that a works can get a seven years exemption. The position is far otherwise. First the Beaver Committee—and the Bill follows it—provides that if the local authority is satisfied there are reasonable grounds, a series of certificates of exemption can be given for a maximum period of seven years. No certificate of exemption can last for more than one year, and it is in the hands of the local authority to decide whether it should be renewed.

The Clean Air Council—I am a profound believer in the need for a Clean Air Council. I agree as heartily as any man could that the Minister must be in control —Mr. Farquharson's point this morning —but in a matter of this kind, where many Ministries are involved, nationalized industries and policy come very much into the picture, public opinion has to be strengthened and informed, and research has to be subjected to the most careful review and forward thrust. I believe that a properly constituted Clean Air Council, along the lines which Dr. Foxwell just touched upon, would be a great support to the Minister. I personally am very hopeful that he will adopt it. I would like to have seen it enshrined in the Bill, but I hope in any case we shall have it. I am much encouraged by the high level of the debate and discussion at this conference, and I believe that the Government, local authorities, industry and the public, will go forward in a great crusade to provide that men and women nowadays shall be able to breathe clean air.

Dr. H. K. Ashworth (St. Marylebone) said that his impression was that the Conference was unduly pessimistic about the Bill, but that he was unable to share this pessimism. When it was seen what Manchester, Coventry, Salford and Bradford had achieved by their own unaided efforts, he felt hopeful of what might be achieved with Government backing. He regarded the Bill as rather like the birch freely displayed in a schoolroom. Some of the twigs might be individually rotten, but the sum total standing in the corner was an effective deterrent to anti-social behaviour. Dr. Ashworth asked that all means should be tried to replace the

rotten twigs before the Bill became law. But whatever the final shape of the Bill, it could not become effective without, as Sir Hugh Beaver had constantly stressed, carrying the tide of public opinion. Everybody present earnestly wanted clean air and he suggested that they should go home and persuade their local authorities to get on with the job of providing it.

Dr. W. R. Martine (Birmingham) said that the stoker problem had been referred to by Mr. Nabarro at a previous session, and now again from the floor. Both speakers had really missed the crux of the problem—the grading of the qualified efficient stoker as a tradesman, as well as adequate remuneration.

The Beaver Committee had been emphatic about the need for properly trained, adequately remunerated and efficient stokers in industry. Stoking was not an obsolescent occupation as a result of increasing mechanization. Mechanization involved instrumentation, which required skill, and there were many small plants which would never be mechanized. Many industrialists were only too ready to have their stokers trained, but there were many more who still could not care less.

The Fuel Technology Advisory Committee set up by the Minister of Education in the West Midlands had for years been exercised about that, and while approaches had been made both to the Employers' Associations and to the Trade Unions concerned—approaches which had been met with a degree of sympathy from both sides—it had proved quite impossible even to arrange discussion of the problem with both parties present. What was necessary was that someone powerful enough should take the representatives of the two sides and knock their heads together. But who was powerful enough and willing to do that?

As regards the future of the Bill, Dr. Martine hoped that all Local Authorities would press their associations to make the strongest representations to Parliament towards strengthening of the Bill and the removal of escape clauses as far as was possible, and that they could take their stand on the grounds of health alone.

The London smog of 1952 may have precipitated a change in public opinion and, tragedy though it was, it had not been to no purpose. More important, however, was the day-to-day effect of air pollution. He was convinced that the findings of the Medical Research Council's team, now nearing completion, would bear that out.

In Birmingham, the incidence of respiratory illness was a very real entity in the City's "black areas"—those in which air pollution was greatest.

No less than 31 per cent. of those claiming medical priority in rehousing in Birmingham in 1954 (31 per cent. in 1953), did so on the grounds of bronchitis and allied conditions. Those applications came, predominantly, from the central areas where recording of atmospheric pollution showed the greatest pollution of sulphur and by solid matter deposited from the atmosphere.

If any Local Authority representative had any doubts, let him read the book, "Air Pollution and Community Health," by Clarence Mills, M.D., of the University of Cincinnati.

Dr. W. R. Chapman (National Coal Board) said that in reading the papers submitted to the Conference he had been struck by the insistent references to coke as if it were the only smokeless fuel, and by the many remarks on the need for new appliances to burn it.

Councillor Gibbons said, "Once used to a good coke fire, there will be no more hankering by householders for an old-fashioned coal fire."

Dr. Burn quoted the complaint, "I don't care what you say, I don't like coke."

There were thus two opinions about coke and the sooner it was well understood that there were alternative fuels and that the future supplies of smokeless fuel would depend less and less on coke, the more popular would the Clean Air Bill be.

Dr. Chapman said that, because of the steps which the National Coal Board had taken and were taking to meet the situation.

The Board was increasing its output of anthracite by 1 million tons/year.

It was increasing its output of dry steam coals by 1 million tons/year.

It was doubling the capacity of its Phurnacite plant in South Wales and its throughput will reach a rate of nearly $\frac{3}{4}$ million tons/year during 1956.

But that was not all. Realizing the trend, the Board, with admirable foresight, had instructed its Research Establishment four years ago to concentrate on producing Phurnacite from the high-rank coals of South Wales and Kent and from the low-rank coals of the Midlands, both

of which, because of swelling and sticking properties, could not be treated without modification of their natural state when using ordinary binders.

The problems were solved, and the Board was giving very serious consideration to the erection of a Phurnacite plant in the Midlands, to treat 1,000 tons of coal a day.

But Phurnacite was not a universal fuel. An open grate and cheaper fuel was required, capable of ignition with sticks and paper, reactive enough to give a good fire in existing open grates and dense enough for easy storage. The solution of the problem, by a modification of the Phurnacite process, was well in sight.

But perhaps one of the greatest contributions resulting from the Board's research was its new process of briquetting without the need for binder. That was done in Germany with brown coal, but had not hitherto been possible, on an economic basis, with black coal. That process, of which two pilot plants would shortly be erected in different parts of the country, could make a most attractive open-grate fuel from small coals with volatile contents under 20 per cent.—henceforth, by Act of Parliament, to be smokeless. The briquettes, from many coals, make a much better fire than lumps of the parent coal. It was possible to blend in some anthracite fines. It could use the low-rank smoky coals of the Midlands and make briquettes for carbonization, and the latter would also be done by a new and much cheaper process than conventional carbonization. Work on this was still proceeding.

In conclusion, Dr. Chapman said it should be emphasized that they were not dreams of mere test-tube shakers—the processes were, in the main, there and ready in a broad sense for large-scale development. They opened up a new age in smokeless fuels and they would justify the statement that coke, though the main solid smokeless fuel of the past, would not be the only smokeless fuel of the future.

Mrs. A. L. Hayes (Electrical Association for Women) referred to clean air inside the home and the fact that shovelling coke, either by shovel or coke hod, created very much dust in the atmosphere. Coke hods needed to be stronger and of better design, and much more attention should be paid to the storage of coke.

With regard to the advisory service mentioned by Dr. Burn, Mrs. Hayes felt that a more efficient and helpful follow-up of installed apparatus could be done far more effectively through the woman housing manager.

Finally, she urged builders and architects of today to build with 20th century ideas and not those of 18th and 19th centuries, so that we should give to the generations of the twenty-first century homes worthy of that age, and not slums.

G. W. Dhenin (Bath) congratulated the Beaver Committee on the speed at which they had provided so comprehensive a report to Parliament. He suggested that in proposed smoke control areas the cost of adaptation of existing private dwellings to conform to the insulation standards, as set out in the Egerton Report, should rank for the 70 per cent. grant. Mr. Dhenin asked if it was not a fact that the implementation of the provisions of the Clean Air Act presupposed the setting up of a National Fuel Policy then.

T. N. Dent (South Western Gas Board) strongly supported the practical points made by Miss A. D. Boyd on the desirability of providing fuel storage space for household coke. He reminded the Conference that during the very cold spell at the beginning of the year, complaints had been made in some parts of the country that the promise of delivery of coke was some seven weeks, following which a national weekly journal had carried out a survey of the availability of coke in the country, and had reported that whilst coke stocks amounted to a quarter of a million tons at that time, neither the Gas Boards nor the merchants had sufficient transport to cope quickly with the huge demand. Mr. Dent pointed out that our winters usually follow the same pattern, of an extremely cold spell lasting from two to four weeks and he considered that it was not financially possible for Gas Boards or coke merchants to maintain the vast transport fleets necessary to cope with that peak period and, furthermore, occasions arose when ice and snow conditions made the roads impassable for heavy coke lorries. He hoped that Local Authority representatives present, who had so vigorously supported the recommendations of the Beaver Committee, would also give strong support to the provision of ample coke storage in their new housing schemes, and indeed their existing houses and flats, so that tenants would have at least 6 cwt. of coke available against any emergency.

Dr. Foxwell, replying to the discussion, assured Dr. Chapman that the increased production of anthracite, low-volatile coals and phurnacite to which he had referred had been disclosed by the N.C.B. to the Committee on Air Pollution and were included in the figures in Appendix XI of the Committee's report. The experiments at Stoke Orchard were known to the Committee, but this process had not got beyond the experimental stage. The pathway to smokeless fuel production was strewn with the wreckage of experimental hopes and abandoned pilot plants. Moreover, the Stoke Orchard proposal, like the phurnacite process, involved several stages and must therefore produce an expensive end product. The Beaver Committee had to be practical and to base its conclusions on known and established sources of smokeless fuel. The process of briquetting without a binder was promising, but even without the binder briquetting would increase the cost of the raw material. However, the more rapid rate of carbonization of briquettes might reduce the capital charges on the carbonizing plant and thus neutralize part of the increased cost of fuel.

Dr. Foxwell also reminded the meeting that the Simon Committee in 1945 had stated that in no other civilized country in the world was domestic heating so uncomfortable and fuel used so wastefully as in Britain. The slum clearance programme and the replacement of obsolete heating and cooking appliances under the Clean Air Act gave to this generation a chance of rectifying the position that might not recur for several decades. He urged local authorities not to be satisfied with the bare minimum of replacement but to see that really efficient, modern appliances were installed for domestic use.

The Sixth Des Vœux Memorial Lecture

THE DESTRUCTIVE EFFECTS OF AIR POLLUTION ON MATERIALS

by

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Introduction

TO be invited to give the Sixth Des Vœux Memorial Lecture is an honour which I greatly value, particularly as much of the work in relation to the problems of measurement and mitigation of air pollution on which my colleagues and I have been engaged over a number of years was initiated and inspired by the earlier work of Dr. Des Vœux, and other enthusiasts associated with him. Dr. Des Vœux began his activities towards clean air in London, and was Treasurer of the Coal Smoke Abatement Society, which was set up in 1898 with Sir William Richmond, R.A., as its first President, and Sir Lawrence Chubb as its Secretary. In 1929, the Society joined forces with the Smoke Abatement League of Great Britain, which had been established in 1909 as a result of earlier activities by pioneers in Manchester, Sheffield, Leeds, Glasgow and some other northern towns, to form the present National Smoke Abatement Society. Dr. Des Vœux, recognized as a leading figure in the movement, became President of the new Society, and occupied this position until his death in 1941.

The pioneers of fifty years ago soon recognized that if the public were to be stirred to action towards a cleaner atmosphere in the interests of public health, there must be more precise information, and not merely vague statements, on the nature and amount of the pollutants, particularly in the thickly-populated industrial areas. In association with Dr. J. S. Owens, Dr. Des Vœux began in 1910 to devise methods for measuring pollution, and to apply the methods in different areas. The results of these early measurements aroused so much interest that in 1912, at an exhibition in London on smoke abatement, a conference of representatives of local authorities and others decided to set up an Advisory Committee on Atmospheric Pollution, which a few years later became a committee of the Meteorological Office. In 1927, the work of the committee was transferred to the Department of Scientific and Industrial Research. In 1945 the Atmospheric Pollution Research Committee was reconstituted as a committee of the Fuel Research Board. This organizational change was not made with any intention of confining the activities of the Research Committee to pollution arising from the treatment and use of fuels, but because air pollution in Great Britain is the result mainly of the use, or rather misuse, of fuels, and to ensure closer co-operation in the work on measurement, and on factors affecting dispersion, with the large amount of work at the Fuel Research Station

on the more efficient use of fuels with mitigation or prevention of pollution.

During the past ten years, the activities of the Fuel Research Station in relation to the identification and measurement of pollution and the mitigation of pollution have been increased, until they now occupy about one-fifth of the time of the total staff of about 300. At the same time, the co-operative work of measurement by local authorities and other organizations has been greatly extended, with the result that the number of measuring instruments in regular use throughout the country has increased from less than 200 in 1945 to more than 1,700 at the present time, and the expansion continues. As a result of all these activities, the Research Station was able to provide a large amount of information to assist the deliberations of the Committee on Air Pollution under the chairmanship of Sir Hugh Beaver. Much still remains to be done before " clean air " or air that is much cleaner than it is now will be a reality in this country. It is certain, however, that the work initiated by Dr. Des Vœux and other pioneers of his time is beginning to bear fruit, though progress is not nearly so rapid as is desirable.

In the Fourth Des Vœux Lecture in 1953, Sir John Charles discussed atmospheric pollution in relation to preventive medicine, and in the Fifth Lecture a year ago Sir Edward Salisbury dealt with air pollution and plant life. To complete the series on the detrimental effects, I have been asked to address you on the destructive effects of air pollution on materials.

Nature and Amount of Pollutants

Though in Great Britain air pollution is mainly the result of the discharge of flue gases from the combustion of fuels, in many areas there are chemical and other manufacturing processes from which are discharged polluting gases, vapours and dusts not directly related to the use of fuels. In the middle of the nineteenth century there was a public outcry as a result of the establishment of processes for making alkali (sodium carbonate) from common salt. From these processes large quantities of corrosive hydrochloric acid were discharged. A Royal Commission was appointed, and following its first report the first Alkali, etc., Works Regulation Act was passed in 1863. Later, the Act was extended on several occasions to include other special processes causing undue contamination of the air. It was consolidated in 1906, but further additions have been made by Orders published in 1928, 1935, 1939, and 1950. The provisions of the Act, which aim at ensuring that the best practicable means are adopted to reduce the amount of pollution, are administered by Alkali Inspectors under the Ministry of Housing and Local Government. The Act now relates to nearly two thousand processes of several different types at more than one thousand works. As the Alkali Inspectors are all men of scientific training and wide technical experience, they have gained the confidence and co-operation of the industrialists operating the processes over which they have jurisdiction. Great progress has been made, but even so, many of these processes still cause undue pollution of the air in their locality, with destructive effects on buildings, metals, paintwork, fabrics, and other materials. If some of the difficult problems involved are to be satisfactorily solved in a reasonable time, research and development work will have to be greatly intensified and extended. Pollution from these special processes, bad as it is in some localities, however, is not nearly so widespread nor so great in amount for the country as a whole as that derived from the combustion of fuels in boilers and other furnaces, domestic heating appliances, and in internal combustion engines.

The most important pollutants discharged from the use of fuels, in relation to their destructive effects on materials, are smoke, grit and dust, and acid oxides of sulphur. From the figures in Table 1, it is seen that in

Fuel and Class of Consumer	Quantity of Fuel millions of tons	Pollutants Discharged millions of tons		
		Smoke	Grit and Dust	Sulphur Dioxide
Coal				
Domestic	37.9	0.9	0.1	0.9
Electricity Works	39.8	small	0.3	1.1
Railways	13.7	0.3	0.1	0.4
Industrial and miscellaneous (*a*) ..	64.6	0.8	0.3	1.8
Coke ovens (*a*)	26.7	small	small	0.1
Gasworks (*b*)	27.4	small	small	0.2
	210.1			
Coke				
Excluding consumption in gasworks and blast furnaces	15.4	nil	small	0.4
Oil				
Diesel and gas oil	3.3	small	nil	0.1
Fuel oil	6.3	small	nil	0.4
Creosote-pitch mixture	0.8	small	nil	small
	10.4			
Total		2.0	0.8	5.4

(*a*) These figures for pollutants include those from coke-oven gas burnt unpurified.

(*b*) Pollution mainly from the use of coke to heat the retorts and to make gas.

Table 1.—Main Uses of Fuels and Estimates of Pollutants discharged in Great Britain in 1954

1954 there were discharged into the air from the uses of fuels about 2 million tons of smoke, nearly 1 million tons of grit and dust, and over 5 million tons of sulphur dioxide. The figures in the Table are given to the nearest 0.1 million tons, so that any estimate of less than 0.05 million tons is entered as "small."

In addition to the fuels mentioned in Table 1, there were consumed approximately 6 million tons of motor spirit, and between 1 and 2 million tons of kerosene, but with the production of little smoke, no grit, and only a negligible quantity of sulphur dioxide, as these fuels contain very little sulphur.

As already mentioned, there are discharges of acid gases, and other gases and vapours from chemical and other industrial processes, not directly related to the use of fuels. Though not so important for the country as a whole, they do cause undue pollution and damage in limited areas. Large quantities of grit and dust are also discharged from cement and lime works, metallurgical works, and other processes not directly related to the uses of fuel for steam and power; it is estimated that the total quantity of grit and dust discharged from these specialized processes in 1954 was in the region of 0.5 million tons, which should be added to the figure of 0.8 million tons in Table 1. It thus seems that the total quantities of

smoke, grit and dust, and acid gases that are discharged each year are 2 million tons, nearly 1½ million tons, and over 5 million tons respectively.

It is common observation that motor vehicles, particularly those driven by diesel engines, frequently emit clouds of black smoke of an oily nature. Such discharges are quite unnecessary provided that the engines are maintained in good order, properly adjusted, and properly operated. They cause not only serious nuisance, but may at times endanger traffic and lead to accidents by reducing the field of vision to other road users. The dirt they deposit on windows, lamp-posts, buildings, and other objects is difficult to remove, and adds to the expense of maintenance.

So far, reference has not been made to air pollution by the invisible gases carbon monoxide, oxides of nitrogen, aldehydes and certain hydrocarbons resulting from the incomplete combustion of fuels in boilers and other furnaces, domestic heating appliances, and internal combustion engines. The total quantity of carbon monoxide so discharged each year is in the region of 25 million tons; the total quantities of the other invisible gases are relatively very small. Though these gases may have serious detrimental effects on health and on plant life, they are relatively unimportant in their destructive action on buildings and other materials.

Distribution of Pollution

The figures so far given for the quantities of the main pollutants are for the country as a whole. But this is not the full story. Much more fuel is consumed in the winter than in the summer, and very much larger quantities are consumed per square mile in thickly-populated industrial areas than in rural districts. Further, the dispersion of the pollutants from their points of discharge is affected by many factors, including the height of the chimney or other point of discharge, the velocity and amount of the discharge, the velocity and direction of the wind, and other meteorological and topographical conditions. Some pollutants are more rapidly deposited or otherwise removed from the atmosphere than are others, and some are more readily dispersed and mixed in the atmosphere. In consequence, the incidence of pollution varies greatly from one locality to another, with time of year and even time of day, and with changes in meteorological conditions. It is important, therefore, to have systematic records of pollution at numerous places throughout the country at different times of the year over a long period of years, if the relative effects in damaging buildings and various materials are to be properly assessed.

As a result of the systematic measurements over a long period of years by local authorities and other organizations in co-operation with the Department of Scientific and Industrial Research, and the many special investigations under the guidance of the Atmospheric Pollution Research Committee of the Department, there is much more information about the incidence of air pollution in Great Britain than in any other country. The results are now being accumulated at the rate of several hundred thousands a year. They are collected and collated at the Fuel Research Station, whence they are issued in the form of a monthly bulletin to all co-operating organizations. Even so, many more measurements are required to cover a wider range of pollutants, and particularly to determine changes from day to day and hour to hour, if some of the important problems to be solved are to be adequately defined.

The standard deposit gauge in common use collects rain-water containing various soluble substances, and insoluble particulate matter that is sufficiently coarse to settle from the air. From the analyses of the soluble matter, the amounts of pollution by acid radicles (e.g., sulphates and chlorides), and basic radicles (e.g., lime), are commonly determined, and the acidity or alkalinity of the rain-water is also measured. The in-

soluble matter is usually analysed for tar, carbonaceous matter, and ash. Deposited matter varies widely in quantity and composition according to the quantity and nature of local and even distant emissions, and climatic conditions. In areas where much coal or other sulphur-containing fuel is burnt, the soluble deposits often contain sulphate radicles in excess of the basic constituents, so that the deposited rain-water is acid and corrosive in character. Coarse particulate matter, consisting largely of partially burnt fuel and ash, process dusts, etc., is emitted mainly by industrial plant, and causes primarily a local nuisance, whereas very fine particulate matter such as smoke, and gases such as sulphur dioxide, may travel over long distances (50 miles and more), causing nuisance and damage in their path.

Amounts of solid matter that are deposited vary greatly from place to place, even over short distances. As a rough indication, pollution by deposited matter in some heavily industrialized areas may be equivalent to more than 500 tons per square mile per year, and may reach as much as 2,000 tons, though such large amounts of deposit rarely occur over an area so large as one square mile. In large cities and some urban areas, total deposits are commonly in the region of 200 to 400 tons per square mile; in rural areas and country towns the amount is normally less than the equivalent of 100 tons, occasionally as low as 10 tons per square mile per year.

Particles which are so small that they show little or no tendency to settle, are referred to as smoke. Mostly they consist of finely divided carbon or carbonaceous matter. Concentrations of smoke at or near ground level range from zero to more than 100 milligrammes per 100 cubic metres of air, which is a value frequently reached in a large city. The concentration usually varies considerably from hour to hour, often showing peaks in the morning and evening. Concentrations may be greater or less at week-ends than during the week, depending on the proportions of domestic and industrial smoke which comprise the whole. In areas in which the smoke is mainly from domestic fires, the amounts in winter are often several times as great as in summer.

In relation to damage to buildings and materials of various kinds, sulphur dioxide is the most important of the gaseous pollutants because of the large quantities emitted into the atmosphere, and because in the presence of moisture and air it changes to the highly corrosive sulphurous and sulphuric acids. In the air of towns at or near ground level, the concentration of sulphur dioxide in winter is in the range of 5 to 100 milligrammes per 100 cubic metres, with much lower concentrations in the summer. It is interesting to observe that at or near ground level, the amount of sulphur dioxide in the air of towns is generally lower than the amount of smoke, though according to the estimates in Table 1, the total quantity of sulphur dioxide discharged is more than twice as great as the total quantity of smoke. There are several reasons for this difference in concentration near ground level relative to the quantity discharged. Firstly, domestic chimneys, which are much lower than industrial chimneys, discharge nearly one-half of the smoke, but less than one-fifth of the sulphur. Secondly, smoke consists of fine particles suspended in the air, while sulphur dioxide is a gas more easily mixed with the air at higher levels, and thus diluted and dispersed. Thirdly, sulphur dioxide is soluble in water, and is therefore more readily removed by absorption in rain, mist, on wet buildings and other structures, and by plants and soil.

Observations during periods of fog, particularly during the severe " smog " of December, 1952, have shown that as a result of the reduced natural ventilation in foggy weather and possibly from other causes, the concentrations of smoke and sulphur dioxide in the air of towns can rise to

several times their amount on a normal day at the same time of the year. In the smog of December, 1952, the concentrations of smoke and sulphur dioxide in some parts of London were ten times as great as on a normal winter day.

Destructive Effects on Materials

In the light of the information so far given on the total quantities of the main pollutants discharged, and the ranges of their concentrations in the air at or near ground level in areas of different types, the next step is to consider the effects of these pollutants on buildings and other materials.

Soiling by Grit, Dirt and Smoke

In dry weather, the grit and dust of the kind collected in the gauges ordinarily used for the measurement of deposited matter, are deposited on the ground, on the roofs, window sills, and other ledges of buildings, and on other structures mostly within a few miles from the points of discharge. The larger and heavier particles fall near the source of emission, and the smaller particles are carried further before being deposited, the distances travelled being dependent on the height of the points of discharge, the velocity and turbulence of the wind, the height of buildings in the area, and the topography of the area. The smaller particles penetrate houses and other buildings through open windows, ventilators and crevices, and are deposited on furniture, curtains and other materials. These deposits increase the labour of cleaning. They frequently contain sharp, gritty matter causing scratches and other damage on the surfaces of the materials on which they are deposited. If the grit and dust come into contact with freshly painted surfaces, they stick to and damage the paintwork, thereby reducing the period before repainting is necessary.

Grit and dust in the air of most thickly-populated industrial areas are contaminated with sticky soot and tarry matter, and frequently they are damp or wet with atmospheric moisture or with rain, so that the particles readily stick to the surfaces with which they come into contact, and are not easily removed. When the particles are moist or wet, they absorb sulphur dioxide from the contaminated air, and this absorbed sulphur oxide is converted to sulphurous acid and then to sulphuric acid, which slowly becomes more concentrated on drying.

Smoke, which consists of very fine particles of soot and tarry matter, is carried in the air over distances of 50 miles or more, much of it being deposited on and within buildings and on other materials in the path of travel. In general, smoke from domestic chimneys has a greater detrimental effect than that from most industrial furnaces, because it is discharged at lower levels, and contains a larger proportion of sticky tar. Smoke is also contaminated by acid compounds of sulphur, chlorides, and other substances.

The experience of my own family has shown that in attempts to maintain an approach to the same degree of cleanliness, the necessary frequency of dusting and polishing furniture, cleaning curtains, carpets and soft-furnishings, and redecorating rooms, is twice as great in flats within the centre of London as in a house nearly twenty miles away in the approaches to the Chiltern Hills. Even in the latter area, as a result of a great increase in the number of houses in the surrounding districts during the last 25 or 30 years, the work of cleaning and redecorating has definitely increased.

Many of the buildings in the Mall and in Pall Mall in London are painted cream or pale buff. Observation has shown that when repainted, even before the paint has dried, the surfaces collect numerous black specks; within two years the buildings have lost their exterior freshness and are distinctly soiled.

A typical example of the soiling effect of the polluted air in thickly-populated industrial areas is well shown by the photograph in Fig. 1

Fig. 1. Buildings in Manchester. The centre building was photographed just after completion in 1935; those on the right of the picture were erected of similar stone in 1927 and 1929.

of the Midland Bank and adjacent buildings in 1935 in King Street, Manchester. This photograph was taken shortly after the Midland Bank building had been erected. At that time that building was white in appearance. The adjacent buildings on the right of the photograph were similar when they were erected about seven years earlier; but seven years' exposure to the polluted air had blackened them. The cost of cleaning buildings in such soiled condition is considerable.

When there are projections on buildings such that deposition of soot and grime is not uniform, partly also because of uneven exposure to wind and rain, some ugly effects can be produced, as shown by the photograph in Fig. 2 of one of Epstein's sculptures on the offices of the London Transport Executive in Broadway, Westminster. This photograph was taken after the sculpture had been exposed for a few years. Epstein gave it the title " Night," but it is unlikely that he intended that it should soon be transformed to a gruesome representation of " Black as Night."

One common soiling effect of the suspended dirt in the air is the marking of walls and ceilings in buildings heated by convection heating systems such as by hot-water radiators and wall panels. This is caused by a phenomenon known as thermal precipitation. The warmed air travelling upwards from the convection heater carries the dirt particles, which are gradually moved by differential molecular bombardment to cooler layers of air against the cold walls and ceiling, with the result that the particles are deposited on these relatively cold

Fig. 2. Epstein's "Night" on a building in Westminster, photographed a few years after its construction.

surfaces. The patterns of light and shade on lath and plaster ceilings are due to the fact that those parts of the ceiling not backed by beams or laths are cooled to a greater extent by air circulating above the ceiling than those that are backed, and the dirt particles are preferentially deposited on the cooler parts of the plaster surface. Soiling of this kind causes unsightly staining, leading to the need for more frequent redecoration with added cost. If the air were pure and free from suspended matter, no staining of this kind would occur.

In some circumstances, soiling by dirt particles is accelerated by electrostatic precipitation. One example is the "fog-marking" of nylon and acetate rayon fabrics during weaving. The exposed yarns in the loom become electrified by friction with the metallic parts of the loom. Owing to their high insulating properties, these yarns retain their electrical charge for some time after the loom is stopped, and attract from the air particles that are neutral or of opposite charge. This effect is shown by a streaky pattern of soiling on the fabric when weaving is continued after an overnight stoppage.

Damage by Sulphur Acids

Before discussing the corrosive action of sulphurous and sulphuric acids formed from the interaction of sulphur dioxide with water and air, it should be mentioned that air, even when unpolluted, contains another acid gas, carbon dioxide, from the natural respiration of plants and animals. This gas is soluble to some extent in water to produce a solution of carbonic acid. Rainwater containing carbonic acid, as it invariably does, slowly attacks limestones to give a solution of calcium bicarbonate. On evaporation by exposure to the air, this solution loses some carbon dioxide and deposits solid calcium carbonate. It is by this process that stalactites and stalagmites are formed in caves. It is clear, therefore, that even in the absence of pollution there would be some attack on stones of the limestone types in damp climates. There would similarly be a slow corrosive action on some kinds of iron and steel, and some other metals. The amount of carbon dioxide in the air of thickly populated industrial areas is greater, often $1\frac{1}{2}$ times as much or more, especially at times of fog, than in pure air, since the main product of combustion of fuels is carbon dioxide. To this extent the natural corrosive action of moisture and rainwater on certain materials may be increased; but it must be emphasized that carbonic acid is a very weak acid in comparison with sulphurous and sulphuric acids, and its corrosive action is much less.

Stone and similar Building Materials: Building stones can be classified broadly into two main groups, those that consist of or contain significant amounts of calcium or magnesium carbonate or both, and those that are practically free from carbonates. Limestones, ranging in hardness and

density from chalk to marble, belong to the first group and are all susceptible to attack by acid in the atmosphere. Sandstones consist essentially of grains of sand cemented together to form a coherent mass, which may be fine or coarse in texture. In some sandstones the cementitious material is predominantly carbonate, which is attacked by acid; in others it is of acid-resistant material such as silica. Extreme varieties of sandstone are represented by the soft calcareous sandstones from the North Downs (Reigate and Gatton stones and Malmstone) and the hard siliceous Craigleith stone of Edinburgh. Granites and similar igneous rocks are generally resistant to acid atmospheres; they sometimes contain calcium carbonate in the form of calcite as an accessory mineral, but in such small amounts as to have little detrimental effect on their durability.

The action of the oxides of sulphur in polluted air in the presence of moisture is to convert the calcium and magnesium carbonates of stone into calcium and magnesium sulphates. Calcium sulphate is slightly soluble in water, and magnesium sulphate is very soluble. On drying the solutions, the calcium and magnesium sulphates form hydrated crystals of greater volume than the original carbonates, with the result that incrustations and friable scale are formed to produce effects known as blistering, flaking, and exfoliation, often also with deep cavities. The extent and nature of the damage are dependent not only on the type of stone and the degree of pollution of the air to which it is exposed, but also on changes in meteorological conditions, the degree of exposure to wind and rain, and the extent of deposition of grit and dust and smoke. Exposure to wind and rain is affected by proximity and height of nearby buildings, and the size and shape of projections on the building itself. As a result, the damage is usually uneven in character and extent.

The presence of grit, dust, and smoke seems to accelerate corrosion. It may be that these particles encourage oxidation of the sulphur dioxide and sulphurous acid to the

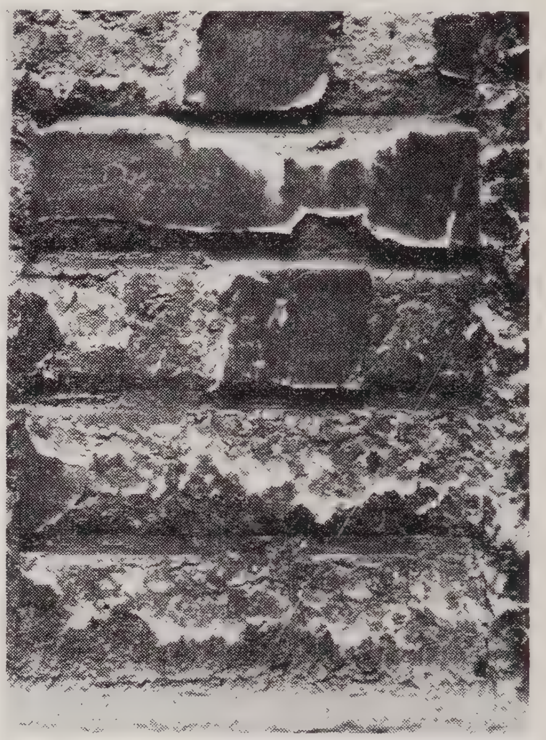

Fig. 3. Exfoliation of a soft limestone (Headington) of an Oxford college.

stronger sulphuric acid, and reduce the extent to which the acid is removed by rain. The photograph in Fig. 3 shows the exfoliation of Headington stone (a limestone much used in Oxford) as a result largely of attack by sulphur acids. Another example of the effect of attack by sulphur acids is shown in Fig. 4, which is a photograph of a piece of the Victoria Tower of the Houses of Parliament; this piece was so badly attacked that it fell away when touched during hand-picking operations in 1922-23.

One example of the destructive action of a damp, acid atmosphere on stone is the deterioration in the condition of Cleopatra's Needle since it was moved in 1878 from Alexandria to the Victoria Embankment in London. That obelisk was originally erected at Heliopolis, then re-erected in Alexandria by Rameses II, whose reign was about the thirteenth century B.C. Incidentally, it must later have been called Cleopatra's Needle because the

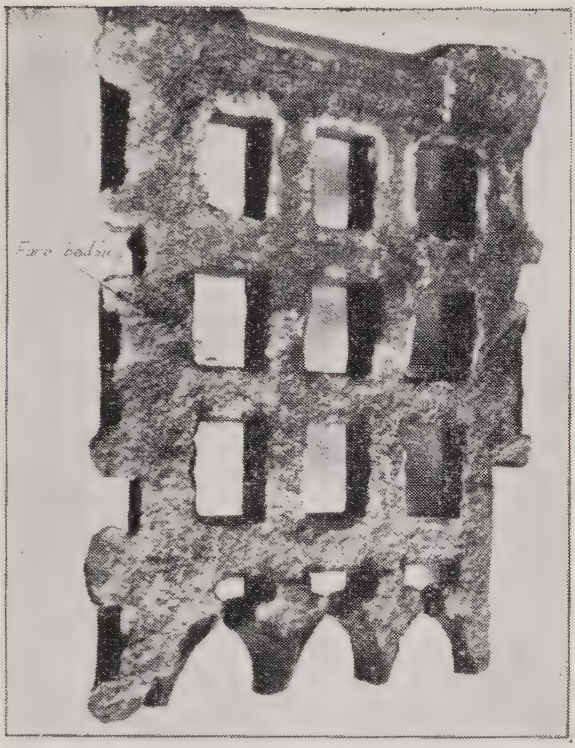

Fig. 4. Stone from the Victoria Tower of the Houses of Parliament. This piece was so badly attacked that it fell away when touched.

reign of Cleopatra did not begin until about 50 B.C. Though the age of the obelisk is at least three thousand years, it has suffered more deterioration during its 70 to 80 years in London than in the whole of its previous sojourn in Egypt.

Slates containing carbonates and the calcareous sandstones often used as roofing materials are attacked by polluted, acid atmospheres. Decay usually occurs mainly on the undersides, especially between the laps, where water is held as a thin film.

Though brickwork can soon become badly discoloured by deposition of soot, it is fairly resistant to corrosion by sulphur dioxide in the air, unless it absorbs sulphates produced by the action of the oxides of sulphur on adjacent mortar and limestone.

Iron, Steel and Other Metals: A large amount of work has been undertaken over a long period of years by many organizations and individuals on the mechanism of corrosion of metals, and on the factors, including the pollutants in the atmosphere, affecting the rate of corrosion. So far as air pollution is concerned, the factor of greatest importance is the extent of pollution by sulphur dioxide, particularly in damp climates. In one series of experiments, for example, specimens of a copper-steel and of zinc were exposed to the air in sixteen places in this country from Surrey in the south to Durham in the north, and ranging in character from a relatively unpolluted country area to a heavily polluted industrial town. At each site the extent of pollution of the air by sulphur dioxide was measured over a year, and the amount of corrosion of the exposed metals markedly increased with increase in the pollution of the air. With the copper-steel it was more than four times as great, and with the zinc it was roughly ten times as great in the highly polluted area as in the relatively unpolluted country area. Other work has shown that the presence of deposited solid matter greatly increases the rate of attack by sulphur dioxide.

It has also been observed that the rails of railway tracks wear more rapidly for the same traffic in industrial than in rural atmospheres, and more rapidly in tunnels traversed by steam locomotives where the air can be heavily polluted, than in tunnels of electrified lines.

In addition to the loss of metal and the destruction of metallic structures, the corrosion can have serious effects on associated materials and structures. The corrosion product has a greater volume than the original metal, so that local intense pressures can be produced in adjacent rigidly-fixed materials. Serious disintegration of stone, caused largely by the expansion of iron on corrosion is shown by Fig. 5, which is a photograph taken in 1921 of a pinnacle on one of the towers of the Houses of Parliament; the iron tie rod to secure the stonework of the finial and weather vane above had corroded and expanded. Another example of damage by expansion of iron on corrosion is shown by the photograph taken in 1922 (Fig. 6) of windows

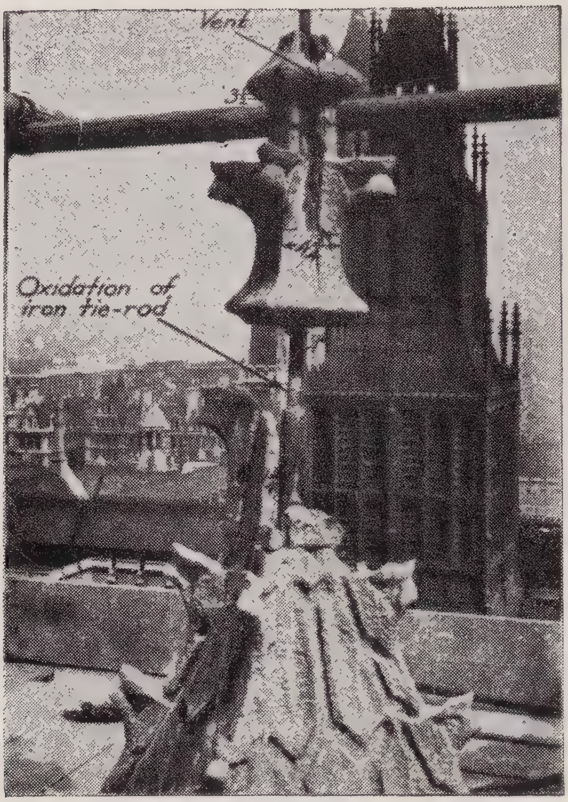

Fig. 5. A pinnacle on one of the towers of the Houses of Parliament. The iron tie rod has corroded and expanded, and thus assisted in disintegrating the stone.

Fig. 6. Windows in a tower of the Houses of Parliament. The iron saddle bars have corroded and expanded and the stone is damaged.

in the central tower of the Houses of Parliament; the iron saddle bars had corroded and expanded causing not only buckling of the bars, but contributing to the damage to the stone mullion.

Leather: It has long been known that oxides of sulphur in the air have a marked destructive action on leather. For example, Faraday in 1843 came to the conclusion as a result of investigation, that the rotting of the leather upholstery of the armchairs in the Athenaeum Club in London was largely caused by the sulphur compounds in the air. More recent investigations by several authorities have confirmed this general conclusion, particularly with vegetable-tanned leather. The deterioration can proceed so far that the leather can be reduced to a powder by gentle rubbing. Experience has shown that the leather bindings of books in libraries in relatively unpolluted atmospheres remain in good condition for very much longer periods than when similarly exposed in libraries in thickly-populated industrial areas. In polluted atmospheres, the rate of deterioration of the leather bindings of books on open shelves is greater in rooms through which there is a high circulation of air from outside, than in rooms in which the rate of circulation of air is small; and deterioration is more rapid on open shelves than in glass-fronted bookcases, as illustrated by the photographs in Fig. 7 of the backs of similarly bound books kept for 40 years on open shelves and behind glass doors in a library in a London suburb. The sides of books kept in closely-packed rows so that air circulation is restricted remain in good condition for a much longer period than the exposed backs of the books.

Leather safety-belts exposed to polluted air can be so attacked and weakened that after a few years they break under a light load and are

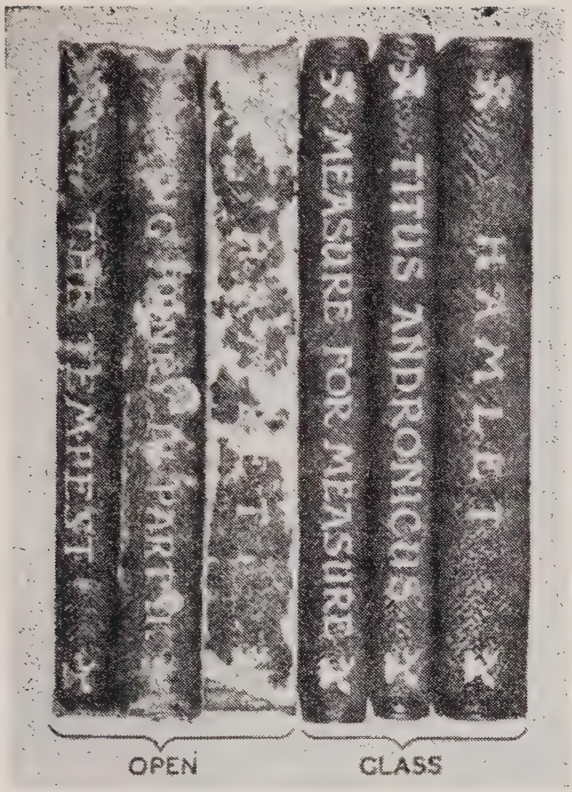

Fig. 7. Leather backs of books exposed for 40 years in a library in a London suburb (a) on open shelves and (b) behind glass doors.

useless for the purpose for which they were intended.

There is no doubt that the attack of polluted air on leather is due to the oxides of sulphur, which are absorbed by the leather and rapidly oxidised to sulphuric acid. Analyses of leather that has rotted under such conditions have shown amounts of sulphuric acid as high as 6 or 7 per cent. of the weight of the leather.

Paper: Though there would be no great loss to future generations if much that is written or printed were destroyed by one means or another—in fact it would perhaps be better if some were destroyed—there are many documents, books and other records of such value that they should be preserved. Yet many of these valuable records are gradually being destroyed by polluted air. As with leather, paper absorbs sulphur dioxide, which is oxidized to sulphuric acid, and this acid not only discolours the paper but renders it brittle and fragile. The rate of production of acid depends to some extent on the nature and amount of metallic salts in the paper, as some of the salts catalyse the chemical reactions involved. As would be expected with stored books, the edges of the pages suffer much greater damage than the middle parts of the pages. Analyses of paper from old books have shown amounts of sulphuric acid in the edges ranging up to nearly 1½ per cent., with differences between the amounts in the edges and the centre of a page sometimes approaching 1 per cent.

Textiles: Though there is a lack of precise information on the damage to textiles by acid oxides of sulphur in the air, it is certain that curtains and other fabrics exposed to frequent changes of moisture content with changes in atmospheric humidity, become fragile and rotted much more quickly in polluted than in unpolluted air. As with leather and paper, they absorb sulphur dioxide, particularly in humid air, and much of this oxide must be oxidized to sulphuric acid. The damage is accelerated by dust and smoke particles deposited on the fabric, as these particles carry acid and often accelerate the oxidation to sulphuric acid. There were many complaints of an unusual amount of damage to nylon hose during the London smog of December, 1952, and it has been stated that "runs" in nylon have been started by the exhaust gases from 'buses on humid days. As might be expected, the finer low-denier stockings are more susceptible to this damage than those of coarser or higher denier thread.

Other materials: In the preceding paragraphs examples have been given of the damage by oxides of sulphur in polluted air to typical materials of mineral, animal and vegetable origin. Of other examples that could be given if time allowed, mention should be made of the damage to valuable pictures exposed in the polluted atmospheres of many areas. This damage may include deterioration of the canvas, paper, and the paint. In the air of many districts there are also minute quantities of another

compound of sulphur, namely hydrogen sulphide, which is emitted when coal is heated and is not completely burned; this gas is also evolved from highly polluted rivers and streams as the result of biological decomposition. Hydrogen sulphide blackens paints with a lead base by converting the lead compound into black lead sulphide; it also tarnishes silver by forming black silver sulphide.

Cost of Damage to Materials

There have been several attempts from time to time to estimate the cost to the country of the damage caused in various ways by air pollution. The most recent and best estimates so far made are those given in the report of the Committee on Air Pollution (Beaver Committee) published in November, 1954. According to those estimates, which are probably on the low side, the direct costs are in the region of at least £150 million a year. This figure includes only the extra cost of laundry, painting and decorating, cleaning and depreciation of buildings, corrosion of metals and damage to textiles and other goods. If the cost of loss of efficiency is added, the Committee estimated the total cost of air pollution to be not less than £250 million a year, and this figure does not include a loss of £25 to £50 million from the imperfect combustion of coals, which causes much of the pollution.

The Remedy

It is not yet practicable in the present state of knowledge entirely to prevent pollution of the air in a thickly-populated industrialized country such as ours. But it is practicable greatly to reduce the quantities of the pollutants discharged into the atmosphere, by determined action on the part of everyone on the lines recommended in the report of the Committee on Air Pollution.

Acknowledgments

In preparing this lecture, the author has drawn not only on the results of the work of the Fuel Research Station, but also of the work of many other organizations and individuals, including particularly the Building Research Station and the Chemical Research Laboratory of the Department of Scientific and Industrial Research, the British Cotton Industry Research Association, the British Iron and Steel Research Association, the British Leather Manufacturers' Research Association, and the Research Department of the British Transport Commission. The author is also indebted to Mr. A. Marsh, Director of the National Smoke Abatement Society, for the photographs in Figs. 1 and 2, the Building Research Station for Fig. 3, the Memorandum on the Defective Condition of the Stonework at the Houses of Parliament published by H.M.S.O. in 1926 for Figs. 4, 5 and 6, and the British Leather Manufacturers' Research Association for Fig. 7.

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NATIONAL SMOKE ABATEMENT SOCIETY

Annual Conference, 1955

Town Hall, Bournemouth

PRESIDENTIAL ADDRESS

by

Sir Ernest Smith, C.B.E., D.Sc.,
F.R.I.C., M.I.Gas E., F.Inst.F.

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Presidential Address

by

Sir Ernest Smith, C.B.E., D.Sc., F.R.I.C., M.I.Gas E., F.Inst.F.

To begin with, I cannot open this address without reference to the loss the Society has sustained in the recent sudden death of Lord Horder, who was to have been my successor as President, and who had been looking forward to being with us today. I need not enlarge on the qualities that made Lord Horder so famous a man, nor on his many achievements, but among them was his keenness—and a very active keenness—for things that promote social well-being, health, and the amenities of life. Among these was smoke abatement. He had been a Vice-President for many years, and he was obviously very pleased when we asked him to accept nomination as President. He was eager to do all he could for the Society. He would have been a tremendous asset to the Society at this important phase of its existence, and I am glad to have this opportunity and privilege of paying him tribute.

This is the 22nd annual conference of the Society, and it creates once again a new record for attendance. We have only to look at the photograph of the inaugural conference in 1929 at Buxton, where the entire meeting was less than the size of our present Executive Council, to see how remarkably the Society has grown.

That small, intimate gathering at Buxton came at the end of a decade of great activity on behalf of cleaner air. There had been the Newton Committee on the Abatement of Smoke and Noxious Vapours—the Beaver Committee was blessed with a shorter title—its prompt and excellent reports, and finally the passing of the new legislation that had been pressed for by our parent associations—the Public Health (Smoke Abatement) Act, 1926.

Yet three years after the passing of the Act the voluntary smoke abatement movement had to be revitalized and a new campaign for clean air had to be begun.

I mention this, not because of forebodings that history is going to repeat itself, but rather as a reminder to a few people—a very few, I think—who suggest that now that the central Government has taken a hand in the campaign, there will be no further need for this Society. I believe that everyone here will agree that the new situation presents the Society with its greatest responsibilities and opportunities so far, just as it gives it cause for satisfaction for the part it has played in creating it.

It is not easy to estimate how much the Society has influenced the shape of things as we see them today, but it is only right to point out that when the Beaver Committee set to work it found, throughout the country, a considerable body of informed opinion, and a broad unanimity of practical views, that had been developed largely through the meetings, discussions and publications of the Society. Not only had the Society brought together all who were concerned about air pollution, but it had filtered and distilled a large variety of ideas into a clear, practical understanding of what the problem was, how it had to be approached, and the lines along which the solutions lay. The Beaver Report is, in effect, very largely an extension and elaboration, in an official framework, of this informed body of opinion.

After these words had been written it was pleasing to find them confirmed by a leader-writer in one of the technical journals. Discussing the Bill and the Society, and kindly concluding

that we were not yet due to fly to that Valhalla in which outworn bodies rest, he went on to say that the Society now had a specialized part to play, mainly among Local Authorities, and that:

> "It has done sterling work throughout its life, and this Bill, even though the offspring of an independent Committee unconnected with the Society, is in fact the culmination of those years of work."

Moreover, the public anxiety about air pollution that followed the shock of the London smog of 1952 could very easily have resulted in all kinds of well-meaning but irresponsible and impractical proposals and demands, had it not been for the core of well-informed understanding that existed throughout the country, again very largely as a result of the years of patient labour by the Society and its members.

We have therefore every reason for looking back with some satisfaction, and even pride, at the achievements of the Society so far—achievements that nevertheless might have been far greater if we had had resources commensurate with the task.

But what of the future? Let us briefly examine the present situation. We are to have a new Act of Parliament, based on the Beaver recommendations, which will have to be administered largely by the Local Authorities, though to some extent by the central Government. For the new Act to succeed it must be used with intelligent earnestness and perseverance throughout the whole country, and it must also be accepted and supported by public opinion. To make it succeed needs therefore the active and continued interest of the Government, the Local Authorities and the public—including, of course, industry. From the very nature of things the Act is unlikely to please everyone, and it may be that some of its provisions will turn out to be less effective in practice than they should be—although it is not likely to fare as badly as did the 1926 Act. In any case, it will be necessary for someone, preferably some critical independent body, to watch carefully the working of the Act and to be ready to say what it thinks.

Further, as the Beaver Committee so well pointed out, there is still a great deal of research and development work to be done, especially on the elimination of fumes and gases, and this too must be encouraged and supported, and the prompt application of its results must be pressed for.

From this very quick and incomplete glance at the near future we can see many important tasks for the Society; tasks which can often be undertaken only by the Society because of its independence, experience and repute. I suggest that they may be listed like this:

(1) To observe, discuss and where necessary make representations about the working of the new Act.

(2) To assist, especially in publicity and education, the more active Local Authorities.

(3) To continue to educate and ginger-up the inactive Local Authorities.

(4) To note and, if necessary, criticize the way the Government departments are doing their part, and to assist them in any way.

(5) To continue to publicize the problem and to educate—and be of service to—the public and industry generally.

(6) To encourage research and developments and to help to make their results known and used.

(7) To continue to act, as we are doing already, though probably to a steadily increasing degree, as a centre for information that is freely available to all.

There is thus a full and important programme before the Society. How it will develop depends on the way the situation in general develops and of the resources—which, of course, means the income—the Society has at its disposal. We all know how we have had to struggle for even the bare

minimum needed to keep the Society alive, and how, although things have improved during the last two or three years, we still have only a fraction (about a fifth) of the income needed to do the work adequately.

It is interesting to reflect that the real reason for this lack of funds is also, fundamentally, the reason for the Society's influence and prestige. It is, simply, our independence.

If the Society were tied to any one particular interest, whether it was commercial, local or central government, or anything else, it would in all probability be much better off, but at the same time much less useful to the clean air cause. Many groups are interested in cleaner air from their own particular standpoint—which may, in itself, be quite a worthy one—but if the Society were to refuse the support of all who had some such interest, it would very quickly cease to exist.

The alternative, which in fact is what has happened, is that the Society should have the membership and support of every kind of interest. From such a broad and balanced membership we have attained a real independence from narrow or sectional interests, and have built up an invaluable forum—as this conference itself demonstrates—where all may express their views, and from which can emerge policies that are practical and effective.

It is not my intention to say a great deal on the Clean Air Bill in this address—there is to be plenty of opportunity for that during this Conference, beginning in a very few minutes. There are, however, one or two observations I should like to make.

The first is that no matter how good the new Act may be in its intentions and provisions, it will not succeed unless it is used with firmness, wisdom and continuity. There is no doubt that it will be so used by many Local Authorities, who are indeed anxious to make much more rapid progress towards cleaner air, but it would be foolish to pretend that there are not others which even today seem to care little about the prevention of smoke. One has only to travel about the country to see instances of smoke emission that reveal both a sorry ignorance on the part of the manufacturers responsible for them, and a serious lack of vigilance on the part of the responsible authorities.

The Local Authorities represented at this Conference are obviously those which take their responsibility seriously—at least I assume that that is so!—and I want you to consider what you should do to bring your more lethargic neighbours into line. Smoke, as we have so often been reminded, knows no boundaries, and I suggest that no question of civic etiquette should stop you from making a fuss about pollution from other areas that affects your own. In some cases, perhaps, the regional smoke abatement committees might act as a clearing house for such mutual gingering-up.

There has been some controversy about one provision of the Bill, which, as the Beaver Report recommended, allows for the more difficult technical pollution problems to be the responsibility of an enlarged corps of Alkali Inspectors. The proposals seem to be most flexible and should give plenty of scope, when the time comes, for discussion and agreement between the Local Authorities and the Minister. I hope that further discussion, especially during this Conference, will not be diverted and bogged down by undue concentration on this point. There is, however, one aspect of the proposed new scheme of things which concerns what I have said about the effective implementation of the Act, and that is the manpower required. The preamble to the Bill mentions an ultimate additional cost for the Alkali Inspectorate of £40,000 a year—which would allow for a score or so of new inspectors. No reference is made to the staff of trained inspectors that the Local Authorities should employ, but it is obvious that to do the work efficiently many more will be needed, and that to obtain the right men—and indeed to reward more adequately the present inspectors —the Local Authorities must be pre-

pared to spend a good deal more money.

The Bill does allow them to spend on research, investigations and propaganda for clean air, and we hope that this may lead to more generous support to this Society, which is anxious to extend its services to its Local Authority members. Part of the publicity needed, I suggest, both by the Society and the Local Authorities themselves, is to show that the increased expenditure needed is well worth while. When we remember that, according to the estimates made by the Beaver Committee, the annual air pollution costs to a town of 50,000 is something like half a million pounds, and so on in proportion, it is not being extravagant to urge the expenditure of five, ten or even twenty thousand a year on its prevention. We have got to get it into our minds, as well as into the minds of the public, that it will pay to tackle air pollution on a scale commensurate with its seriousness.

A further point about the Bill is about the one form of air pollution that is excluded from it—that caused by road vehicles, and particularly that due to diesel engines. This omission is due to the fact that the Road Traffic Act, and regulations under it, are considered to be adequate. That may be so, but here we have an excellent example of what I have just been saying—that an Act is of little value unless it is fully used. The Road Traffic regulations, which are the concern of the police, are rarely implemented, despite the obvious and indeed alarming growth of this particular kind of pollution. If we are to secure a substantial abatement of the unnecessary fumes and smoke from badly adjusted or badly operated vehicles—particularly from the older types of petrol-driven car and from all kinds of diesel vehicles (which perhaps need something new in design)—then either the present regulations must be more energetically used or they must be replaced by something better. The police, we all know, already have their hands pretty full controlling the vast, and still growing swarms of traffic that today congest our roads so acutely, but it should not be difficult, or asking too much, for them to be more active and aggressive in this matter.

According to a letter in the *Manchester Guardian* recently, some police forces are in fact taking cases to the courts, but the writer—a police inspector in a Lancashire town—complains that they are never reported in the local press. As publicity about this problem, to build up public opinion, is of the greatest importance, I would like to take this opportunity of appealing to the Press, both national and local, to report proceedings of this nature whenever they can.

I drew attention to this problem at some length in my Presidential Address at Scarborough last year, but make no apology for returning to it today, particularly as the menace is visibly becoming more and more serious, as I saw personally during a recent journey by road from the south of Scotland and back. It is curious that road users in general do not protest more forcibly, but then this is simply one more aspect of the carelessness with which we pollute the atmosphere and the apathy with which we suffer the consequences. In fact, the way we pollute the air with smoke and fumes is largely due to the same habits of mind that cause us so disgracefully to litter our streets and parks, and the places that once could be called beauty spots, with masses of paper, tins and bottles. The British seem to be supreme at fouling their own nest with every means that is available to them.

In my address to you last year I spoke of the crisis, or revolution in the use of fuel, and our attitude towards it, that is now in progress. That crisis has recently become more acute and difficult. Coal production is falling, and we are having to import foreign coal at great expense, so that all the coal we use, and all its derivatives, have become dearer. Some radically minded people in the past have urged that the price of coal should be drastically raised in order to en-

force its more efficient use—a policy that never won very wide support. But now we are finding ourselves forced into it, though for other reasons. If the higher price of fuel does in fact result in it being used more economically, thus materially reducing its consumption, then in the long run dearer fuel may prove to be a blessing in disguise. We must continue to emphasize that smoke prevention and economy in the use of fuel are closely linked together. The Clean Air Act will not only help to give us cleaner air, but will help to lessen the severity of the fuel supply difficulties that are looming up more and more threateningly.

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NATIONAL SMOKE ABATEMENT SOCIETY

Palace Chambers, Bridge Street, London, S.W.1

BOURNEMOUTH CONFERENCE

28th—30th September, 1955

Members and Delegates Attending and Authorities, &c., Represented

List corrected to 19th September; for additions and alterations inquire at the Conference Bookstall

National Smoke Abatement Society

Bournemouth Conference, 1955

LIST OF MEMBERS AND DELEGATES ATTENDING

Adams, G. R. F., Cllr., *Felling*
Aitken, R., Cllr., *Dunfermline*
Alford, J. E. R., Cllr., *Llanelly R.D.C.*
Allen, T., *G. W. B. Furnaces Ltd.*
Allwood, T. (CSI), *Bingham R.D.C.*
Anderson, C. W., Dr. (Deputy MOH), *Cardiff*
Anderson I. B. (SI), *Port Glasgow*
Anderson, J. F. (CSI), *Edinburgh*
Andrews, B., Ald. Mrs., *Luton*
Appleton, F., Dr. (MOH), *Brighouse*
Appleton, W. F. (CSI), *Portsmouth*
Archer, A. (CSI), *Halesowen*
Armstrong, E. A., Ald., *Derby*
Ash, I., Dr. (Deputy MOH), *Newcastle-under-Lyme*
Ashford, T. (SSI), *Glasgow*
Ashton, A., Cllr., *Bentley-with-Arksey*
Ashworth, H. K., Cllr. Dr., *St. Marylebone*
Aspin, G. D. (Chief County Health Inspector), *N. Riding Yorks. C.C.*
Austen, T. W., *Woodall-Duckham Construction Co. Ltd.*
Axford, R. L., *South Wales Division, C.E.A.*

Baigent, H. R. J., *Southern Electricity Board*
Bailey, H. D. (SI), *Holborn*
Bailey, J. M., Cllr., *Birmingham*
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British Iron and Steel Federation
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W. C. Moss
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Department of Scientific and Industrial Research
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NATIONAL

SMOKE ABATEMENT SOCIETY

FUMUS FUGETUR

Proceedings
of the
Southport Conference
1956

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The Society's Publications

This is one of the many publications of the National Smoke Abatement Society. For a complete list write to the Society for its current Year Book. This contains a Guide to Publications on Smoke Prevention and Allied Subjects, which lists, in addition to the Society's own titles, particulars of other books, reports and papers, including Government reports, any of which may be purchased from the Society. The list is classified according to subject—the Law, Conference Proceedings, General, Historical, Smoke Prevention Administration, Industrial Smoke, Domestic Heating, Technical and Scientific, and Industrial Pollution.

NATIONAL SMOKE ABATEMENT SOCIETY

Proceedings of the 23rd Annual Conference Southport

October, 1956

Palace Chambers, Bridge Street, London, S.W.1.

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To Authors and Participants in Discussions

SUMMARY OF EVENTS

The Conference created a new record of attendance, with 679 delegates, members and speakers. The previous highest total, in 1955, was 578. 291 Local Authorities and 72 other organizations were represented. Press publicity also reached a record figure, with over 500 cuttings received.

Wednesday, 3rd October

The proceedings opened in the morning, with an address of welcome by the Worshipful the Mayor of Southport, Councillor F. E. Thornley, J.P. Sir Ernest Smith, C.B.E., who was in the Chair, then gave his Presidential Address. He was followed by the Parliamentary Secretary to the Minister of Housing and Local Government, Mr. Enoch Powell, M.B.E., M.P., who spoke on the Clean Air Act. Mr. Powell kindly agreed to answer questions, and this part of the session added greatly to its interest and value.

The afternoon session, with Dr. J. S. G. Burnett, a Deputy Chairman of the Executive Council, in the Chair, consisted of four Progress Reports. Dr. J. P. Lawther, Director of the Medical Research Council's Group for Research on Atmospheric Pollution, read a paper on the health aspects of air pollution, and Dr. Handley H. Howell, Consultant Radiologist to the Weston-super-Mare Hospital Group, read a paper on the problem of air pollution from road vehicles. Discussion on these two papers was taken together, and they were followed by a paper on solid smokeless fuels, under the title of "The Way to Clean Air," by Mr. D. P. Welman, Chairman of the North Western Gas Board, and by a paper on other aspects of solid smokeless fuel production, by Dr. W. Idris Jones, C.B.E., Director-General of Research, National Coal Board. In the absence of Mr. Welman his paper was read by Mr. W. Hodkinson, O.B.E., now Deputy Chairman of the Board.

On Wednesday evening the members of the Conference attended a most enjoyable Reception in the Floral Hall, by invitation of the Mayor and Mayoress.

Thursday, 4th October

Mr. John Innes, a Deputy Chairman of the Executive Council, presided at the morning session, the subject of which was "Local Authorities and the Clean Air Act." Papers were presented by Alderman C. H. Goulden, of Salford, Mr. H. V. Cass, of Oldham and Chairman of the N.W. Divisional Council of the Society, and by Professor Andrew B. Semple, Medical Officer of Health for Liverpool. The last speaker also showed a number of coloured slides.

"Clean Air and the Housewife" was the subject of the afternoon session. With Mrs. D. M. Charlton, a member of the Executive Council and Chairman of the Women's Advisory Council for Solid Fuel, in the Chair, papers were presented by Mrs. M. Courtney, Chairman of the National Union of Townswomen's Guilds, Miss J. G. Ledeboer, Architect and Chairman of the Housing Centre Trust, and Miss J. M. Akester, Superintendent Health Visitor, City of Leeds.

Friday, 5th October

The first part of the session on the Friday morning was the Des Vœux Memorial Lecture, read by Sir Hugh Beaver, K.B.E., on the subject of "Clean Air: the Next Chapter." Then followed the Annual General Meeting, at which the election of Dr. R. Lessing as President was announced. Dr. Lessing received the badge of office from the Chairman of the meeting, Mr. F. J. Redstone, and in a short speech intimated his pleasure in accepting the office. Resolutions

which are given at the end of this volume were put to the meeting and were adopted without dissent.

The annual general meeting and conference were concluded by the moving by Dame Vera Laughton Mathews, D.B.E., Past-President, of a general vote of thanks to all who had contributed to making the conference so successful: the Mayor and Corporation of Southport, the Chairman and members of the Publicity and Attractions Committee, and especially to the Publicity Officer, Mr. H. R. Morton; to all the sessional chairmen and authors of papers; and to the Society's staff. The resolution was carried with acclamation.

Councillor G. H. Tanner, B.E.M., then conveyed to the Executive Council and the conference an invitation, on behalf of the Mayor and Corporation, to hold the 1957 Conference in Hastings. The Chairman intimated that the Society would be very pleased to accept the invitation and to have the honour of meeting in Hastings on 2nd October next.

Sessional Chairmen :

Wednesday, 3rd October	Morning:	Sir Ernest Smith, C.B.E., D.SC.
	Afternoon:	Dr. J. S. G. Burnett, M.D., D.P.H.
Thursday, 4th October	Morning:	John Innes.
	Afternoon:	Mrs. M. D. Charlton, B.SC.
Friday, 4th October	Morning:	F. J. Redstone, F.R.S.H., F.S.I.A.

Presidential Address

by

Sir Ernest Smith, C.B.E., D.Sc., F.I.C., M.Inst.Gas.E.

HAVING delivered, in previous years, the two formal addresses normally required of a President, I propose to make only a few informal remarks on this occasion—all the more desirable because the meeting is obviously eager to hear Mr. Enoch Powell, M.P., Parliamentary Secretary to the Minister of Housing and Local Government, on the Clean Air Act.

The Act is to be so thoroughly discussed in the Conference that it is not necessary to refer to it other than to say that although the Society was critical, as were many others, of the original draft and did all it could to secure improvements, we now must recognize that the Act is settled and that we cannot expect another for at least a decade. Therefore it is up to the Society and everyone to work to ensure its fullest possible success. The Act can be interpreted in detail in many ways; those who are enthusiastic can interpret it widely; those who are indifferent or do not think it is necessary to do anything, can point to details and say " we can't do this," or " we can't do that," or " we can't push it as far as this or that." I would like to draw your attention to the fact that there has been a very very useful analysis of the Act in the journal called *Coke and Gas* by Dr. Foxwell, who was a member of the Beaver Committee, that gives an analysis and an indication of just what certain difficult passages mean. So those who are really conscientious and really want to help in clearing the air can get guidance from that in preference to worrying many people who will give different interpretations.

In my view, industry is working along lines generally which are all in our favour. Those that are new and big enough in capital and otherwise are able to spend the money in revolutionary changes, are doing so, and a remarkable change has taken place in the efficiency in which fuel is being used in many industries. We have only to take, for example, the steel industry and the amount of fuel used per ton of steel, per ton of pig iron, compared with a few years ago. The chief problem that we have in front of us is really the domestic consumer. The other problem is in implementing and compelling certain industries that are obviously—if you look back 20 miles east from here—polluting the atmosphere in a way which, often with only a little capital, it is possible to eliminate. We also have the question of the railways; that is a matter that is progressing and will take time; but their smoke will have to be reduced and it is being reduced.

As regards road vehicle fumes, and in this connection I would mention the enormous amount of research work that is going on, through the Fuel Research Board, the medical authorities and in many other directions, I do urge that no one will be deterred from pressing for improvement merely because there is no finality in our knowledge of which particular constituent causes cancer or gives pneumonia or bronchitis and the like. We all know that dirty air is bad for breathing; we don't need to know as individuals and men in the street what exactly it is that is causing that poisonous atmosphere. We know it is there, and to wait for years to determine whether the medical people say it is this, that or the other, does not matter a rap; we know it is rotten

and we have to stop it.

This problem of road fumes was discussed in the last two presidential addresses and is to be dealt with in papers and discussions this afternoon. The problem is increasing largely because the present law, explicit though it is, does not seem to be adequate or to be effectively administered. It may be that it will be useful for the Society to get down to examining the law and its application and to considering whether there may be a case for a different form of control and administration.

The Society

Now that people have had more opportunity of measuring the problems that must be faced if the Clean Air campaign is to make real progress, the idea—which in any case was held only by a few—that the Society's task was over, has quite disappeared. Everyone now sees that the Society's biggest and most responsible work is only just beginning. This is not just an ambitious hope but is being borne out by experience. We are finding that more and more of our small resources, and they *are* small, and the time of our staff, are having to be devoted to services that are expected from the Society by Local Authorities, the Press, students, technical people and so on. We are participating in the West Midlands Clean Air Campaign and our modest exhibit and incidental expenses are costing us an amount which, though quite small by commercial standards, represents nearly 10 per cent. of our income for the year. Now we have to have a much bigger income, and I think the Executive Council has to take its courage in its hands and go out for getting a very much bigger income by one means or another. We have not discussed this in detail. So far it has depended on personal requests, primarily from industrial concerns, which have had a very good response. But we do feel, and I feel it personally, that in view of the fact that the great majority of our members are Local Authorities, there ought to be a very much greater contribution from them to the work of this Society than we are getting today, and I shall be putting proposals forward shortly to see what the agreement is on the Council for asking for that. I am just warning you that it should not come as a surprise if the Council does decide to back what I have in mind.

It is gratifying to find that over 650 delegates and members registered for this Conference. We have once again achieved a record. It is particularly interesting to note, compared with earlier years, such a large representation of Government Departments, other Associations, the Fuel and Power industries, and private firms—74 bodies in all with 111 delegates. An interesting development is that one of our Local Authority members, the Royton Urban District Council, asked if we would agree to them approaching industries in their area and urging them to appoint delegates. The Conference is, of course, an open one and we are delighted at this proposal, which we hope in future may be taken up by other Local Authorities. At least two industrial delegates present are here because of the invitation extended to them through the Royton Urban District Council and we welcome their presence.

A cordial welcome is also extended to delegates from the Municipality of Rotterdam, Dr. J. W. Tesch and Dr. H. de Graaf. They are the only delegates from the Continent but we hope they may return next year with others and that our meetings may begin to take on an international character.

Another indication of our influence is the way in which the press are supporting what we are doing. I do not know whether you saw the London *Times* on Monday, 1st October, but here is a full-scale fuel efficiency supplement with some extraordinarily good short articles on fuel efficiency and smoke abatement, and showing what certain cities in the U.S.A., that have really been troubled in a similar way to ours, have done. Nine times out of ten you find people say "Ah yes, but the conditions are different there." If they were talking about

Los Angeles it would be so, but Pittsburgh and St. Louis were troubled in a similar but much more difficult way than we have been in this country. They have solved their problem and they have done it with the agreement of the natives. (I do not know whether the Americans like you to call them natives: I should not mind being called a native of this country.)

Among recent events of note mention may be made of the excellent comprehensive supplement on the Clean Air Act published by the Leeds Chamber of Commerce; the forthcoming conference being organized by the Institution of Mechanical Engineers on " The Mechanical Engineers' Contribution to Clean Air," to be held in February; and the series of exhibitions and other events being carried out throughout the autumn and the winter in the West Midlands.

Then there was the extra-mural Course on Air Pollution held last week in Sheffield and recent valuable sessions on the problem at meetings of the Sanitary Inspectors' Association and the Royal Society of Health and other bodies. It should not be overlooked, and I say this with some hesitancy because I am interested in it, that the Institute of Fuel has done a great deal in this connection. Their local sections rarely miss one session in any year without a good discussion on smoke abatement in conjunction with the Society. Another thing outstanding is that our Director, Arnold Marsh, spends much of his time in giving lectures to bodies that are not always connected with the technicians, but often with the general public, in talking and illustrating what can be done, and I do not think we can thank him too much for the work he is doing in giving these lectures. I think I have said enough to indicate to you that we on the Council and this Society are as keen as mustard to get things going to support the Act. I have said enough to indicate that we need more money, and we have got to try and get more money.

Now I have got the greatest pleasure in the world in calling on Mr. Enoch Powell, Member of Parliament for Wolverhampton South West and Parliamentary Secretary to the Minister of Housing and Local Government. As a private member he supported Mr. Nabarro in the latter's Clean Air Bill. He took a very large part in steering the Government's Bill, now the Clean Air Act, through its Committee stage in the House of Commons, when he impressed all by his remarkable understanding of every detail and the ease and lucidity with which we could explain even the most difficult points. We are very proud to have him here today.

The Clean Air Act

Address by

J. Enoch Powell, M.B.E., M.P.

Parliamentary Secretary, Minister of Housing and Local Government

ANYONE addressing a conference of this Society who is not himself an expert and specialist in any of the subjects which its interests cover is in grave danger of "teaching his grandmother"; and for the mere politician, however close an interest he has taken in clean air, the difficulty of finding something new to say to you is almost insurmountable. I think that I can claim to be no stranger to your purpose. From my first entering Parliament, I took part in, I believe, nearly every debate involving fuel conservation.

My name was one of those on the back of the private Member's Bill tabled by my friend, Gerald Nabarro, at the end of 1954, and in my present Office I took part in every stage (after Second Reading) of the passage of the Clean Air Bill through the House of Commons. I hope, therefore, you will be prepared to regard me at least in the light of an associate.

My presence here today, however, is not in a personal capacity but as evidence of the Government's enduring practical concern in the reduction of air pollution. This concern is not, as sometimes suggested, of recent date; and the provisions of the Clean Air Act are sufficient in themselves to ensure that it will be continuous and protracted.

I could go back to pre-war, even pre-first war public health legislation, but will be content to start by pointing out that the Beaver Committee itself was a Government Committee.

It is sometimes said that committees are appointed as a means of deferring rather than stimulating action, but that was certainly not true in this case. Within two months of the publication of the Committee's report, the Minister announced in the House of Commons that the Government accepted the Committee's recommendations in principle, and a fortnight later, at an opportunity provided by the Second Reading of Mr. Nabarro's Private Member's Bill, the Government undertook to introduce a comprehensive Bill on the lines of the Committee's recommendations.

The report of a Departmental Committee on such an intricate and important problem can seldom have been acted upon so speedily by the Government of the day.

Since the Clean Air Act reached the Statute Book in July, a host of new Government responsibilities have come into existence, the most obvious of which is to bring the Act itself into operation.

I have already announced elsewhere that the Minister intends to fix a day before the end of this year for the commencement of the provisions relating to smoke control areas (Sections 11-15), new furnaces (Section 3), the height of chimneys (Section 10) and various other provisions of the Act which will be required in connection with those Sections.

For the purposes of this stage, certain other machinery is necessary. Regulations are in preparation to prescribe the authorised fuels for use in smoke control areas, and the Minister will be making an Order in due course in regard to the appliances

which are to be exempted from Section 11 of the Act. The latter, it will be remembered, gave rise to a good deal of discussion during the passage of the Bill through Parliament, when fears were expressed in some quarters that these exemptions would tend to defeat the purpose of smoke control areas.

The Minister intends, however, to interpret strictly the words in Section 11(4) " without producing any smoke or a substantial quantity of smoke," and to exempt only those methods of firing which can make a real contribution to the abolition of smoke, without consuming the authorized smokeless fuels.

The Minister will also, in due course, be making regulations under Section 4 regarding the use of smoke density meters, and under Clause 7 in regard to the measurement of grit and dust emissions from furnaces. At his request the British Standards Institution are already at work on the preparation of specifications for both these purposes.

As local authorities avail themselves of the provisions for creating smoke control areas, the Minister's duty of considering and confirming the orders which they make will come into play. This will, in certain cases, involve the holding of local inquiries.

Smoke control areas too involve Government participation of a quite direct and concrete kind—the paying of an automatic contribution towards the expenditure duly incurred by local authorities and private individuals in the necessary conversion or replacement of appliances.

The Main Dish

Though this first administrative mouthful will require some mastication, the main dish of the meal will of course be served when, in the spring of 1958, the remainder of the Act, that is to say, the provisions for the prevention of dark smoke, grit and dust, provisions mainly affecting industry, will be brought into force.

This is in accordance with the Beaver Committee's recommendation that a suitable interval should be allowed to enable industry to carry out any necessary alterations and improvements to plant and equipment in order to comply with the new requirements.

May I take this opportunity once again to stress, and to ask your Society's help in stressing, that although these provisions will not be in effect for eighteen months, it is during just those eighteen months that the bulk of the work which they necessitate ought to be done. People must not suppose that they can wait till 1958. The less use that is to be made of the temporary provisions in Section 2 the better. I may also add the less use that is to be made of prosecutions and penalties the better.

I may take the opportunity at this point of saying a word about Section 2 of the Act, which deals with the 7-year " period of grace " as it has been called. It is not quite that.

It should be clearly understood that the Section does not allow any general exemption from the prohibition of dark smoke in Section 1 of the Act during the 7-year period. It will afford only a limited defence—limited in scope and limited in time. To establish the defence, it will be necessary to prove that the emission of dark smoke was due to the nature of the building or its equipment—and not to lack of maintenance or improper use, and that the necessary alterations or new equipment could not have been completed by the time the contravention occurred. Even by the appointed day for Clause 1, eighteen months or more will have elapsed from the passing of the Act, so that the number of cases in which the defence could be pleaded successfully after that date are likely to be few, and to become progressively fewer as time goes on. It should be noted, and we hope that industry generally will have taken notice of this, that the 7-year period in Clause 2 runs from the passing of the Act, another reminder that if alterations or improvements are needed to comply with Section 1, they should be under-

taken now and not deferred. If they are deferred, when they might have been carried out, the defence in Section 2 will be of no avail.

"Smoke prevention," you may say to me, "begins at home"; and certainly the Clean Air Act, when fully in force, will bite on Government property as well as private property, and impose new requirements on the nationalized industries. I think in the first place of the National Coal Board's new duties in relation to colliery spoilbanks. I think of the Admiralty in relation to naval vessels. I think of the chimneys of Crown and Government premises of all kinds—I see that Professor Semple has obligingly illustrated one in his paper. I think of the British Transport Commission and the provisions concerning railway locomotives.

I could go on with this list for quite a time; but would refer to wider responsibilities which are connected with clean air, though they have other important bearings, responsibilities which the Clean Air Act has thrown into sharp relief. Availability of fuel for instance—the responsibility in the last resort of the Minister of Fuel and Power, but one in the discharge of which the concern of his colleague at the Ministry of Housing and Local Government with clean air, can never be left out of account.

The practicability of much of the domestic aspect of our Clean Air Policy depends on the supply, the price and the quality of smokeless fuels, and especially of the solid smokeless fuels. It is only logical that no fewer than a quarter of the material submitted to this Conference is concerned with smokeless fuels.

The Special Processes

I have not finished there. Since the first Alkali Act of 1863, the Alkali Inspectorate, which works under the Minister of Housing and Local Government, has been charged with the duty of ensuring the proper control of pollution from certain industrial processes, those processes which are liable to cause pollution of a particularly serious nature, but in which control is a matter of special technical difficulty. The Beaver Committee's recommendation, which the Government have accepted, that some further industries should be scheduled under the Alkali Act, has created a certain amount of controversy. It is but an extension of the same principle. The problem of the "special processes" is not simply one of enforcement—of seeing that a particular works complies with the general law; it is a question of devising and applying practicable means of reducing pollution to the desired level where special technical difficulties exist, not only at a particular works, but perhaps over the industry as a whole, wherever it is carried on. That will be the function of the Alkali Inspectorate, as regards the further industries which will be scheduled under the Alkali Act. The Minister will, in due course, make an Order for this purpose, after a public inquiry and consultation with the local authorities and other interests concerned. There is no need to regard this as a controversial matter or as a bone of contention between local and central government. Local authorities and the Alkali Inspectorate have worked in close collaboration with one another in the past. They will have concurrent powers under the Act in regard to smoke, grit and dust, and I have no doubt that harmony and collaboration will continue in the future.

The Clean Air Council

The Minister will shortly be proceeding to appoint the Clean Air Council under Section 23 of the Act, which, if I may quote the actual words of the Statute, is "For the purpose of:

(*a*) keeping under review the progress made (whether under this Act or otherwise) in abating the pollution of the air in England and Wales; and

(*b*) obtaining the advice of persons having special knowledge, experience or responsibility in regard to prevention of pollution of the air."

Thus the Council will be a consultative one. There have been suggestions in the past that it should be an independent authority wielding executive powers, but that would have been constitutionally unsatisfactory. It would have led to overlapping functions and would have impaired the Minister's responsibility to Parliament. The co-ordination of the work of the different Government Departments is the province of the Government itself, and could not properly be undertaken by an independent body. The Council will, however, work directly with the Minister—he will be its Chairman. It will comprise representatives of all the interests concerned in the prevention of air pollution—industry, local authorities and the fuel producers. It will provide a forum for the discussion of all aspects of the problem, and should exercise an important influence on the development of future policy and progress.

This brings me naturally to research and the future. I was bold enough, perhaps unwise enough, to say during the passage of the Clean Air Bill that I trusted it would not be the last during my Parliamentary lifetime.

Several known aspects of air pollution were left outside the Bill, not because Parliament failed to recognise their importance, but because, by the general consent of qualified opinion, legislation would be premature and impracticable in our present state of scientific and technical knowledge. Here I have in mind sulphur pollution, in some respects a more harmful pollution than the more visible and obvious pollution of smoke. So far as sulphur gases are associated with smoke, the Clean Air Act should automatically bring improvement, but a good deal, perhaps a growing amount of sulphur pollution not associated with smoke, will remain.

Then there is the whole question of fumes from motor transport, petrol and diesel. Here, again, we do not yet really know enough, either about the nature of the nuisance, or still less about methods of prevention, to be within sight of legislative control. But in regard to this and other forms of atmospheric pollution, the Government are not complacent.

Research and development work on this, and other air pollution problems, is being done by the Department of Scientific and Industrial Research, the Medical Research Council and by other bodies, such as universities and industrial research associations.

Incidentally, the D.S.I.R. Advisory Council has, until quite lately, been fortunate in having Sir Hugh Beaver as its Chairman. Among its other activities, the Fuel Research Station of the D.S.I.R. has been engaged on studying methods of reducing smoke from domestic appliances, the production of reactive coke at gasworks, and the various problems associated with pollution by motor vehicle exhausts. The Fuel Research Station has also been directly concerned in, and in a large measure responsible for, the development of the ammonia process of removing sulphur oxides from flue gases, which is now being tested at pilot plant scale by the Central Electricity Authority.

The Conference will be familiar with the comprehensive system of measurements of air pollution which is being carried out by a large number of local authorities and other bodies in co-operation with the Fuel Research Station. This work is of fundamental importance, since we must have accurate knowledge of the incidence and characteristics of the problem we are dealing with.

More than that, an efficient system of measurements and records will be indispensable in future in order to show the results obtained by our control measures.

Here again, in the kind of work which lays the foundation for future legislation, your Society is active. Your deliberations this afternoon, I notice, commence with two progress reports on the kind of matters I have just mentioned. And so I would end this brief review of the Government's concern with clean air by giving recognition to the importance of what

your Society does in this field, above all, by helping to create the indispensable foundation of all successful administration, an enlightened and enthusiastic public opinion.

Discussion

The President said that the Conference had had one of the most valuable contributions that could have been made. He was happy to say that Mr. Powell had kindly agreed to answer any specific questions that were put to him on the Clean Air Act.

Councillor Lang (Battersea) asked why, in view of the air pollution density in London, when Battersea Health Committee protested against the change-over from trolley-buses to diesel engine buses, they were turned down?

Mr. Powell: I think I partly answered that question in my remarks when I frankly admitted that pollution by road vehicles is one of the aspects of clean air which, for the time being, has been left outside the Clean Air Legislation. We have to know a great deal more about cause, and particularly about prevention, before we can legislate on this subject. I would remind you that it is no use legislating unless it is practicable to comply with whatever Parliament lays down. Nothing, I think, has done more harm in the past than the existence on the Statute Book of provisions which it has not been fully practicable to put into effect and to enforce. We do not want to make that mistake in the future. Pollution from road vehicles is undoubtedly an important problem, but until we are sure that we can grapple with it fully and effectively it would, I believe, be wrong to attempt legislative provisions.

Councillor W. L. Ellis (Bermondsey) asked whether the Clean Air Act curtailed in any way the powers by which Local Authorities could deal with the nuisance of sulphurous fumes from factories.

Mr. Powell: I can assure you that nothing in the Act reduces any powers which a Local Authority had in these matters before its enactment, so there is no question of the Clean Air Act having taken anything away. What I was dealing with in my speech was the question as to whether we should have gone further and prohibited forms of atmospheric pollution by sulphur gases which have been outside control hitherto, and I have suggested to the Conference that until it is practicable, economically and technically practicable, to eliminate sulphur pollution, it is impracticable to legislate against it; but I welcome the opportunity of making it clear that nothing which has been unlawful, nothing against which proceedings could in the past be taken, has escaped by reason of the Clean Air Act.

Councillor Boston (Wakefield) referred to Section 11, on smoke control areas, which in Sub-section 7 stated that the Minister may suspend or relax the operation of a Smoke Control Area Order, although he must first consult with the local authority. There was some doubt as to what this might mean, and he asked if the Minister could enlarge on the point.

Mr. Powell: The object of this provision in Section 11 is to deal with emergencies in which the requisite smokeless fuel may physically not be available for some temporary and unforeseen reason in a Smoke Control Area. If there were no provision of this sort in the Act, the result would be that thousands of offences under the law, which the offenders had no means of avoiding, might be committed. It is wrong for Parliament to make people guilty of offences which they cannot avoid. Parliament must not prescribe actions unless those actions can be carried out by the citizens to which the law applies. Therefore, it was necessary to provide that the Minister could take emergency action where he was satisfied that unforeseen and urgent causes had interrupted the supply of smokeless fuel which was necessary for complying with Section 11. His obligation under the Act to " consult the Local Authority unless he is satisfied that, on account of urgency, such consultation is impracticable "—those are the words of the Act—means *consult*, and does not imply that the Minister is either bound by the view of the Local Authority or that in emergency he cannot dispense with it. The situation envisaged is that of a national emergency; one in which the Minister and the Central Government have the responsibility for knowing what the fuel situation is and what the movements of fuel are likely to be throughout the country. In those circumstances the Government might well have to act very quickly in order to prevent Section 11 from becoming an absurdity, but the existence of those words in the Act is evidence that it is the Minister's intention in doing so, where-

ever humanly possible, to act in co-operation with the Local Authorities who have the Smoke Control Areas.

G. H. Wilkinson (Corby) said that the Parliamentary Secretary had referred to the need for intensive research in the specialized industries. The Local Authorities were going to be asked to submit annual reports on the progress they were making, and the Alkali Inspectorate likewise. In America, industry was required to submit annual reports on the progress of its research. Did the Parliamentary Secretary think there was any possibility of that being imposed in Britain?

Mr. Powell: I have every reason to think that the Government and para-Government Research bodies are in close touch with what their opposite numbers in industry are doing, and that there is no lack of co-operation between Industrial Research and Government Research on these matters. If this is so, I would have thought there was nothing gained, and perhaps something lost, in imposing a statutory obligation, accompanied presumably by penalties, upon private bodies and private individuals to do what they are already doing quite voluntarily.

Councillor W. A. N. Jones (Birmingham) asked why did the Government find it so necessary to impose purchase tax on real smokeless fuel appliances, the use of which it wished to encourage?

Mr. Powell: I am not here, of course, to answer for my colleague, the Chancellor of the Exchequer, though I would observe that if the arguments against imposing purchase tax on one article and on another article were added together, it would rapidly dispose of purchase tax. It is not for us this morning to decide whether or not that in itself would be desirable, but to consider more seriously the cost of changing over to smokeless fuel. I agree that is very nearly the heart of the matter, especially where the domestic smoke producer is concerned; and I thought it very interesting and encouraging that so much of the papers which are to be put before you in these next two or three days are concerned with the economies of smokeless fuel in the domestic sphere. If I have read those papers aright, they indicate that there is good hope of domestic smokeless heating being economically advantageous as compared with domestic smoke production, and I would venture to think that the element of capital expenditure in the installation of the appliance would be rapidly swallowed up by the economies achieved in the operation of the appliance over a time. While, therefore, the cost of the appliance, to which in smoke control areas there is a Government and Local Authority contribution available, is undoubtedly important, I think we have got to look, as you are looking in this Conference, at the economics of the smokeless appliance as a whole.

Dr. H. L. Settle (M.O.H., Doncaster) said that the physical nature of many of the artificial smokeless fuels was sponge-like and they could retain considerable quantities of moisture. He wished to ask whether the Government was considering introducing regulations to control the amount of moisture permitted in smokeless fuels, or alternatively a scheme for selling them by volume instead of by weight, in the interest of the consumer?

Mr. Powell: There, I think, you have got me right out of my depth and off my pitch. The responsibility in such a matter is clearly not that of my Ministry but of the Ministry of Fuel and Power, and possibly the Board of Trade as well, and I think the best thing I can do is to leave that question on the record, so that it will doubtless come to attention.

Councillor Eric Gibbons (Brierley Hill) said that when the investment allowances were suspended in this year's Finance Act, a certain limited range of fuel-saving industrial pieces of equipment were still allowed the Investment Allowance, but plant for the cutting out of air pollution, which did not come on that limited range, was specifically rejected from inclusion in the list of plant subject to the Investment Allowance. He knew that this was again rather getting near the Chancellor of the Exchequer, but perhaps Mr. Powell could give a little enlightenment.

Mr. Powell: I do not think I can job back over the Finance Act of the current year, but I would make one general observation which is prompted by the question, and which I have made on the floor of the House of Commons more than once before, and that is, that, from the industrialists' point of view, smoke prevention—which means fuel efficiency—is anyhow a good bargain. Looking aside entirely from the question of the initial allowances, it is a good bargain for industry to change over from the inefficient to the efficient use of fuel and that truth is one of the weapons which this Society has at its command in its campaign.

R. Williams (C.P.H.I., Coventry) asked how soon his and other Authorities could expect suitable quantities of reactive coke. Now that they had to deal with domestic premises, it would be necessary to determine not only what amendments and alterations and adaptations were necessary in each private house, but how many fires in each private house had to be converted. The cost would be material and could, of course, be very drastically reduced if reactive coke, which could be burnt successfully in the ordinary fire-baskets, were available.

Mr. Powell: I fully recognize the importance—and I deliberately made this point in my remarks—of the quality, as well as the price, of the smokeless fuel which is going to be available in Smoke Control Areas. It would clearly be impossible for me to give a quantitative answer to the question which I have just been asked, but the importance of qualities of fuel, and particularly of coke, is fully recognized in connection with the establishment of Smoke Control Areas by the Government. I can assure you that its importance has not been overlooked and that, when I made my general statement about the availability of fuel to match progress in the creation of Smoke Control Areas, this point was included.

G. Nonhebel (Individual Member) asked if it would be possible to bring into force Section 1—The Prohibition of Dark Smoke—until the list of scheduled processes under Section 17—Special Cases—had been issued?

Mr. Nonhebel's second point was that in Section 1, under the clauses for Defences, Sub-section 3, the Government had added a new paragraph 3(*d*) which read " that the contravention complained of was due to the combination of two or more of the causes specified in paragraphs (*a*) to (*c*) of this sub-section, and that the other conditions specified in those paragraphs are satisfied in relation to those causes respectively." He asked if Mr. Powell could make clear to the Conference the meaning of this.

Mr. Powell: The first question is whether an order scheduling additional processes under Section 17 is a necessary pre-condition of the bringing into force of Section 1. The answer to that is—Yes.

The second question is what does Section 1(3) sub-paragraph (*d*) mean. The sub-section in which the offending paragraph occurs deals with defences in proceedings for having emitted dark smoke. They are the defences with which if the emitter of dark smoke makes good, he can get off. The first (*a*) is that the contravention was solely due to lighting up, and that all practicable steps to prevent or minimize the emission of dark smoke had been taken. So that is one defence. If he uses that defence he must prove that there was no further cause at all but the fact that he was lighting up. He must prove that he has modern equipment, properly used, in a proper building; that everything else ruled out dark smoke but that it was only, *solely*, because he was lighting up. (*b*) That the contravention was due to a failure which could not have been foreseen or, if foreseen, could not have reasonably been provided against. So, if the offender uses this defence, he must prove that everything else was right; that nothing within his control, or indeed outside his control, had gone wrong except that there was a failure of the furnace or the apparatus. He must rely entirely on *failure*, because the word is *solely*.

Under (*c*) the defence is in regard to unsuitable fuel. Now may I just pause for a moment to make this particular sentence clear than I think it has ever been to a great many people who have criticized it. The defence here is not use of unsuitable fuel. It is not a defence to say " I was using unsuitable fuel." The defence is to prove that the emission of dark smoke was due solely to the unsuitable fuel; that is to say, that the furnace itself was capable of being used without producing dark smoke—that it was a modern furnace, that it was properly operated, that it was in proper order. And not only that, but the defence must also prove that, of the fuel available, the least unsuitable was used, and that all practicable steps were nevertheless taken to minimize or prevent emission of dark smoke.

Thus, so far, the offender has got three possible defences. He can prove that the offence was *solely* due to lighting up, and nothing else; or he can prove that it was *solely* due to a mechanical failure and nothing else; or he can prove that it was *solely* due to unsuitable fuel in the circumstances and under the limitations which I have described, and nothing else.

And now, why paragraph (*d*)? Well, suppose that you had to light up a furnace with unsuitable fuel. You'd be dished! You couldn't prove that the offence was due solely to lighting up because, bless me, you've got unsuitable fuel! You couldn't prove that it was due solely to unsuitable fuel because you were lighting

up. And suppose there were a mechanical failure while you were lighting up? Washed out! There would be no defence, because you could not make good that essential word, " solely." Therefore paragraph (*d*) had to be inserted to make it possible to ensure that one of these " solelys " shouldn't rule out the other—that one defence which Parliament had thought good should not nullify another defence which Parliament had also thought good.

I am very glad to have had the opportunity of going through this Clause because it has enabled me, not only on this point of detail but I hope more generally, to show that these defences are in fact very tightly drawn indeed in the Act, to emphasize that the onus of proof is on the defender. It is he who has got to make good these defences—it is he who has to exclude all other causes and prove that, *solely* for the reasons specified, dark smoke was emitted; and I venture to think that it is going to be very difficult indeed, and that the paragraph to which attention was drawn has only had the effect of making the Section in an Act of Parliament sensible instead of rather absurd.

James Law (Vice-President) said that Mr. Powell would be aware that, throughout the country, there was a dearth of Public Health personnel. He asked what preparation the Government were making for the training and manning of the staffs that would be necessary to work the Act, and to carry out the various regulations, which would require men of very special calibre?

Mr. Powell: I hope I shall not be thought guilty of prevarication if I point out that the recruitment and training of sanitary inspectors falls under the responsibility of the Minister of Health and not the Ministry of Housing and Local Government; but generally it would be right to recognize that the Public Health Inspectors of Local Authorities by reason of this Act, are going to have both enlarged responsibilities and enlarged requirements in regard to their qualifications. They are the people on whom the brunt of carrying out this Act is going to fall, and if the Local Authorities, and the country at large, wants the Clean Air Policy to be put into practical effect, it has got to provide itself with the necessary number of Public Health Inspectors, who must have the right qualifications. This matter, as so many others, comes down in the last resort to the personnel who are going to do the actual job. In this case the personnel are the Public Health Inspectors, and I certainly recognize that the Act involves an increase in their strength and a strengthening of their qualifications.

The President, in concluding the session, said: I think you will all agree with me that we have had a brilliant session with the Parliamentary Secretary and that, coupled with his really satisfactory and useful address, we have been very lucky to have him here today at a time when he is more pressed than ever in his official duties. Sir, I am not going to keep you from your train any longer, but to thank you most heartily on behalf of the whole of the Smoke Abatement Society for your great contribution to the progress of the Clean Air Act. Thank you very much.

Progress Reports

THE CLINICAL SIGNIFICANCE OF DIRTY AIR

By

P. J. Lawther, M.B., M.R.C.P.

A pupil of Aristotle named Theophratus published his "History of Stones" in 371 B.C. and noted therein that certain black fossils burned for a long time and made a troublesome and disagreeable smell. Twenty-three centuries later it must be admitted that medical science, whilst curing disease with drugs which an advanced technology has produced from the black fossils, has virtually nothing to add to the observations of Theophratus other than to give them emphatic confirmation. It has for long been recognised that the proper solution of the problem of the effects of air pollution on health is the abolition of pollution but this is a slow process; in 1288 King Edward I ordered his officers and City Sheriffs to seek a remedy for the smoke nuisance in London and in 1956 we are assured that soon we will have clean air to breathe. We are not yet to be relieved of our task of investigating the effects of dirty air on health; indeed, recent manifestations of the acute effects of high urban pollution have made the task one of desperate urgency.

In addressing the Smoke Abatement Society it is a pleasure to be relieved of the necessity to plead the case for clean air but it must be emphasized that, with a few notable exceptions, belief in the harmful effects of dirty air must still be largely intuitive. Such belief may be sufficient for the ardent propagandist who is advocating the only sensible course of action (and fortunately it is he who is responsible for the progress in this field) but it leaves unanswered many pressing practical problems. We will only get cleaner air by gradual stages and medical research must be directed to the incrimination of specially harmful pollutants so that their suppression may be given appropriate priority; means of protection of susceptible people against the effects of intense urban pollution must be devised, and the long term effects of relatively low degrees of pollution must be investigated. It has been admitted that we have as yet little incontrovertible positive medical evidence to offer. Since this field has never lacked investigators of great ability and zeal the fact that we know so little about the clinical effects of dirty air can only be an indication of the complexity of the problem.

Knowledge of the physical and chemical nature of air pollution is of fundamental importance and to acquire it is a formidable analytical task. The samples of dirt collected on filter papers and the gases scrubbed out in wash bottles bear no more than a crude resemblance to the complicated structure and chemical activity of the pollutants as they exist in the air; they are as like the stuff we breathe as a haggis is like an angry pig. Using orthodox sampling methods we get a physical wreck of particles which once had specific size, shape and structure; we get an algebraic sum of chemically active constituants. In order to get a meaningful picture of the pollutants

which we inhale new physical and chemical techniques must be employed and modified in the light of what is learned by their use. Electron microscopy is revealing the complex structure of particulate pollutants and we are gradually elucidating the chemical nature of particulate and gaseous contaminants by using analytical techniques by which we were able, as it were, to get cross-bearings on the various constituents some of which interfere with each other the moment they are collected on filters or in solution. Though we know more than we did about the nature of air pollution every slight advance in our knowledge shows us how much we have yet to learn. We know that in smog, contrary to earlier supposition, the fog droplets are very rarely associated with smoke particles; that acidic and basic particles co-exist in the air; that if sulphur dioxide is physically adsorbed on smoke particles, as has been suggested, it cannot be displaced by ordinary methods; that concentrations of smoke and sulphur dioxide may vary enormously and rapidly during temperature inversions this fact greatly lessening the significance of 24 hour average figures.

Whilst it is fundamentally desirable to know the nature of air pollution this knowledge is of great immediate practical importance. The information is needed in order to test the physiological effects of individual pollutants; the physical state of particles is important since their size and structure influence depth of penetration and site of retention in the respiratory tract; the effective design of protective devices such as smog masks and air conditioners requires adequate chemical and physical data. It must always be remembered that air pollution is not static but is in a state of constant chemical and physical change. It is quite likely that in periods of intense pollution reactions between pollutants occur which would otherwise be impossible because of their extreme dilution, and new and dangerous substances may be formed.

The clinical effects of air pollution are even more difficult to study. It cannot be denied that acute pollution produces acute effects as has been seen in the various smog episodes which have so rightly added a sense of urgency to our work. It seems likely that chronic low-grade pollution produces chronic effects over the years; air pollution is a suspect aetiological factor in the production of chronic bronchitis and lung cancer. The problems of acute and chronic effects are likely to be related only distantly since it is almost certain that acute pollution is qualitatively as well as quantitatively different from ordinary urban pollution.

The effects of acute pollution are the less difficult to investigate. Broadly speaking, two techniques are available: One can study carefully the clinical history and condition of patients affected by smog and attempt to correlate these data with the nature of the pollution to which they were exposed. The second technique is supplementary and necessarily ancillary to the first; people may be exposed experimentally under controlled conditions to various suspect ingredients of smog and the effects, particularly on pulmonary function, noted. Neither technique is separately sufficient and even when both are applied thoroughly a solution can only be expected if the problem is in reality a simple one.

The Effects of Smog

We know a little about the effects of smog. No definite clinical syndrome which could be called " Smog disease " has been recognized in any of the episodes despite careful retrospective investigations. It has been noted that the clinical conditions of some patients affected by smog is very similar to that which could be expected to occur in an exacerbation of their existing chronic disease. Signs of bronchospasm are common findings. It seems that an increased mortality, chiefly among patients with chronic pulmonary and cardiac disease

coincides with the high pollution attendant on a temperature inversion. We have found that the high level of pollution is irritant quite independent of the presence of fog. It is notable that patients who are affected adversely during one episode are not necessarily so affected by another. There is no evidence to suggest that all smogs are similar in composition. Experimental exposures of normal people and chronic bronchitic patients to sulphur dioxide in various concentrations higher than those reported in smog episodes have had various effects on their respiratory resistance—a few develop bronchospasm, others are unaffected, and in other cases the gas acts as an expectorant and results in a marked decrease in respiratory resistance.

Van Sim and Pattle, working at Porton have exposed healthy young males to several possible constituents of smog and have concluded that their effects are largely due to non-specific irritation and are not systemic in nature. Pattle's excellent work with animals supports this conclusion.

This picture, confused as it seems at present, is compatible with several hypotheses the most important being also the simplest. It may be that there is no mystery about smog; high levels of urban pollution are irritant and the excess mortality might merely comprise those patients with pulmonary and cardiac disease of such severity that they are unable to withstand several days of continuous respiratory irritation. It may be objected that modern smogs are much more lethal than the pea-soupers of yesterday and that this fact implies the existence of some new sinister constituents. Though this may well be so it is necessary to remember that the population at risk is significantly different from that living before the major therapeutic advances of recent years. Patients with chronic heart and lung disease are now being protected by antibiotics, anticoagulants, diuretics, surgery and many other therapeutic agents, from infections and exacerbations which years ago might have killed them. Their lives are therefore prolonged but they might be left more susceptible to stresses against which we have not yet devised protection. The irritation of smog may well be such a stress. While this is not necessarily a complete defence of the objection to the simple hypothesis, it remains an important fact which is frequently forgotten. The irritant constituents in smog are as yet not fully identified and in this connection it is important to beware of ascribing the effects solely to sulphur dioxide on the existing evidence. Sulphur dioxide and smoke are estimated routinely because of their obvious noxious character and they are relatively easy to determine. They are useful indicators of general pollution and they accumulate in the air during temperature inversions. To blame either of these contaminants for the effects of smog is to ignore the hundreds of other compounds which are present and not yet determined. It is noteworthy that concentrations of pollutants measured in smog have not reached levels anything like those permitted for continuous exposure in industry.

The experimental approach to the smog problem is made difficult by the perversity of man in that he does not react to noxious gases or aerosols in a manner proportional to their concentrations. In biology there is rarely a linear relationship between cause and effect and all-or-none responses are common. These facts make dangerous any attempts to extrapolate results obtained in experiments using concentrations of pollutants such as are allowed in industry; nor can the results of short experiments be safely used to predict the effects of continuous exposure during a three day smog. The results of experiments on young normal subjects are of limited value in that smog tends to affect acutely the chronic sick and elderly; experiments on chronic bronchitic patients must obviously be greatly limited in extent and aim only at producing effects which may be quickly reversible, such as broncho-

spasm. It will be perceived that experimental work designed with these necessary limitations in mind will tend to produce negative results rather than to incriminate individual suspect pollutants. When we have worked our way through all these substances singly we will have only scratched the surface of the problem. It would be naïve to expect to find a single cause for the disasters when so many retrospective attempts to do so have failed; synergistic action, climatic factors, coincidence and antecedence of specific infections (viral or bacterial), fear (especially that engendered by journalistic warnings of impending doom) must all be expected to play their part.

These complexities which face the investigator make the simple hypothesis of non-specific irritation seem attractive but, what is of great practical importance, they render imperative an empirical approach to the problem. They emphasize, if emphasis were needed, the desirability of abolishing pollution; but until this becomes possible smog masks and air conditioners must be tried. It is known that very small amounts of ammonia will neutralize acid mists and gases and Wilkins of the Fuel Research Station has designed ammonia dispensers which promise to be useful. These and other protective devices are being given careful trials.

Effects over the Years

Smog sets the acute problem which has catalysed activity on the much greater question of the effects of breathing dirty air over the years. The high incidence of chronic bronchitis and lung cancer in towns lead one to suspect air pollution as the cause but to prove the relationship is immensely difficult. A great number of unpleasant aspects of town life merit equal suspicion. Those who live in towns are subject to repeated cross infection of the respiratory tract and they usually work indoors out of the sun. Housing conditions, occupational hazards, nutrition, family histories, smoking habits, income, and social status, may all differ significantly in urban and rural populations and it is unlikely that these factors do not play some part in the production of chronic lung disease. It is almost certainly true that prolonged physiological trauma is necessary before chronic bronchitis or lung cancer is produced and this separation in time of cause and effect make the truth difficult to discover; any improvement in health which might be expected to result from the abolition of air pollution might not be manifest for many years. Huge long-term epidemiological studies such as that reported by Stocks and Campbell are necessary to study the part played by dirty air in the production of lung cancer. The techniques needed for the investigation of the chronic bronchitis problem are necessarily even more complex in that the disease is much more difficult to define clinically. Several pilot studies are in progress and careful planning followed by years of observation will be needed to throw light on the problem. It will be a matter for rejoicing if, before the results are obtained, the abolition of air pollution reduces the problem to one of mere historic and academic interest.

Motor Vehicles

We foul our air by burning coal and this is our largest source of air pollution. No review of our miasma could in fairness omit some mention of pollution by motor vehicles to which so much publicity has recently been given. Petrol and diesel engines emit substances which if inhaled in sufficient concentrations are harmful to man and rightly merit the close attention of those who deplore the pollution of the air they are obliged to breathe. That much confusion of thought on the subject exists is evident from some recent attacks on motor vehicles and a restoration of some sense of proportion is badly needed in this corner of the air pollution field. If power is to be obtained from the combustion of fuel it is obvious that the degree of dilution in the air of the products of combustion must be known before

any assessment of their possible effect can be attempted; it is more important to know what is present in the air breathed than what comes out of exhaust pipes and though this latter knowledge is of great value it can easily be misapplied. It is possible that the uncritical application of the excellent analytical work that has been done on diesel engine exhaust products is partly responsible for the outcry against this form of traction; it is difficult to find any satisfactory explanations for a campaign which has been often ill-informed and sometimes irresponsible. It is time to redress the balance of guilt between petrol and diesel engines. The properly designed and well maintained diesel engine is a very efficient means of converting fuel into power. It need not emit black smoke if properly adjusted and this is especially true when it is de-rated as is the practice of many large users. The law forbids the emission of black smoke from motor vehicles and this law ought to be enforced rigorously. It is notable that in the many criticisms of the diesel engine, mention is very rarely made of one of its great advantages over the petrol engine; it emits very little carbon monoxide. Ironically, among the multitude of pollutants we have to study this gas is the only one of which we have extensive and fairly precise toxicological information.

The diesel engine is often blamed for the rise in the incidence of lung cancer but there is absolutely no evidence to justify this allegation. It is true that 3:4 benzpyrene has been found in the soot collected from maladjusted engines; it has been found in the exhausts from petrol engines and it is present in comparatively large quantities in town smoke. The fact that the rise in incidence of lung cancer has been synchronous with the increased use of diesel traction not only cannot be used to incriminate diesel engines but points to some factor which has been operating for a much longer time.

We are at present investigating air pollution by motor vehicles. We are examining the exhaust products as they issue from vehicles and the air inside garages where pollution is high. It is a long and complex investigation but we are able to report some preliminary results. Many samples have been taken simultaneously from the air inside and outside a large London Transport Executive diesel bus garage throughout two nights. During the first night urban pollution was high and though there was much more soot inside the garage than outside analyses showed that the benzpyrene contents of the air were virtually the same. On the second night there was very little town smoke in the air outside the garage and results showed that it is possible that the buses might have added a very small amount of benzpyrene to the garage air but the small differences noted could not be established with any degree of certainty. It is certain that the concentration of 3:4 benzpyrene did not rise in proportion with the concentration of smoke. It is also certain, by comparing results on the two nights that any contribution of 3:4 benzpyrene by the 200 buses in the garage is negligible in comparison with the fluctuations which may arise from the varying levels of smoke outside. The smoke from the buses must have contained little, if any, benzpyrene and certainly less than coal smoke. These findings have been supported by the results of experiments we have carried out on individual buses running round a test track at London Transport's Chiswick works. No 3:4 benzpyrene has been detected in the smoke from buses in average condition, but in samples from others, small amounts have been found. In all cases the proportion of 3:4 benzpyrene in the soot has been smaller than that found in coal smoke and experiments are continuing in order to determine the conditions under which it is emitted. Our results are in accord with the findings of other workers who have found no benzpyrene in the exhaust from properly maintained diesel engines though they have found considerable

quantities under conditions of inefficient operation. It is important to note that London Transport de-rate all their buses by 10 per cent in order to reduce the possibility of heavy smoke emission and they also ensure, by carefully arranged maintenance routine, that they are kept in excellent mechanical order.

During these surveys we measured the concentrations of many pollutants none of which approached levels generally considered to be "threshold". We are ready to apply these techniques to petrol vehicles. Wilkins has reported the results of a survey of the carbon monoxide content of street air and has done a valuable job in focussing attention on a possible hazard about which many have felt uneasy for some time. His results agree with measurements we have made. We have been doing some direct experiments with private cars. In a probe investigation we drove through the streets of London for three hours with the car windows shut and the air intake on. 130 p.p.m. carbon monoxide were found in the car and the blood CO of the passengers doubled. Our passengers were normal people and these levels were not harmful but we are as yet unable to say that they would be of no significance to diseased people. This work is continuing.

Town dwellers are obliged to travel and it is worthwhile considering the amount of vehicle pollution emitted per passenger carried. The exhaust of a diesel bus must be divided by the number of passengers it carries and the private motorist appears in a very unfavourable light when the same test is applied to his share of pollution. When we are justifiably indignant at smoking diesel haulage vehicles—they ought not to be emitting smoke—we must not forget railway engines firing-up in our city yards; likewise we ought not to delude ourselves about electric traction—it is coal fired at a distance, and frequently the distance is inadequate.

If this brief survey of our field of work has dwelt overmuch on the complexities of our task it serves to emphasize the need to abolish pollution summarily. In clinical research on air pollution we must constantly submit to our own devil's advocacy and preserve a humble attitude to a great problem. We have no more right to expect an easy solution than to overlook one. The history of preventive medicine is strewn with problems which have been solved only by years of patient careful work. Considered in a different context the tubercle bacillus is an atmospheric pollutant; it is minute, rendered visible only with difficulty, has no immediate effects but produces many varied clinical and pathological pictures: The invention of the microscope and the development of the science of bacteriology were needed before we could learn the full story of this "captain of the men of death". On the other hand many ills, including malaria, were once attributed to our miasma and we now know better. Problems look so easy when we know the answer. The formidable problem of the effects of air pollution has one great weakness—we possess the radical solution. We have only to apply it and the whole evil will vanish.

THE HEALTH ASPECTS OF AIR POLLUTION FROM ROAD VEHICLES

By

Handley B. Howell,

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The purpose of this Paper is to draw particular attention to the effects on health of the air pollutants associated with the use of oil. No originality is claimed for any research carried out, the object being rather to sift and correlate the findings of research workers on this subject to date.

It has been my lot to carry out radiological investigations on many thousands of chests annually for the past 20 years. In the course of this the obvious increase in chest diseases from irritant causes, and particularly the alarming increase in lung cancer, has given me much food for thought, especially since the middle years of the last war.

It occurs at first sight that atmospheric pollution has reached a dangerous level in this country. Furthermore something has been added in the form of a pollutant which has taken an increasingly significant effect since the early part of the third decade of the present century. With these two points in mind the rapid increase in the use of the internal combustion engine, and especially those of the heavy oil or diesel type, strikes one as a very possible answer. Along these lines my searchings began in 1945 and have continued to the present. My chief sources of information come from the U.S.A. We, in this country, until very recent times, have been taken up largely with the question of tobacco smoking and lung cancer, and any attempts at stirring up interest into the pollution caused by oil fuel have been coldly received, even ridiculed. On the contrary, our American friends have taken up the research in a most whole hearted and forthright manner.

The history of many investigations and the attempted control of air pollution are, I am sure, well known to you all. These date back some hundreds of years with spasmodic attempts at legal control. Strange to relate, both world wars interrupted such measures when they appeared to be reaching a promising stage and in turn, post war problems delayed their resumption.

The most important laws and regulations pertaining to the present subject are the Road Traffic Act of 1930, subsequent Regulations made by the Minister of Transport on 10th January, 1931,[1] and in Motor Vehicles (Construction and Use) Regulations 1955[2].

In the Road Traffic Act Regulations 1931, No. 17 (in Part 1), the following is laid down, " Every motor vehicle shall be so constructed that no avoidable smoke or visible vapour is emitted therefrom ". In the same Regulations No. 67 (in Part 11) and again (Part 3, Para. 79) the following is laid down, " Every motor vehicle shall be maintained in such condition and shall be so driven and used on the road that there shall not be emitted therefrom any smoke, visible vapour, grit, sparks, ashes, cinders or oily substance, the emission of which could be prevented or avoided by the taking of any reasonable steps, or the exercise of reasonable care or the emission of which might cause damage to other persons or property or endanger the safety of any other users of the road *in consequence of any*

harmful contents therein". Alas these rulings have not been observed or enforced. The reason is twofold, firstly public apathy, secondly the reaching of such proportions that the police are powerless to control it. As Sir Hugh Beaver so rightly said in his brilliant address at the First International Congress on Air Pollution in America: "On public opinion, and on it alone, finally rests the issue".[3] I believe that the fostering of this opinion is one of the major aims of this Society.

Until recent years all problems of atmospheric pollution have centred around the congested industrial areas being almost wholly concerned with the products of coal combustion. Naturally this leads to a concentration on the sulphurous elements and coal soot or ash. When the fumes of the internal combustion engine arrived upon the scene there occurred at first (indeed it yet persists) an obsession over the carbon monoxide emission. This lethal gas is barely worth consideration in the dilutions prevailing. There are three main types of pollutant in the engine exhaust—solid, liquid and gaseous. All three are modified in the atmosphere by physical and chemical changes.

The solid elements are soot (oil carbon) and ash. The former acts as a vehicle for some of the unburnt fuel, it may act under some circumstances as a catalyst, and by its vast adsorptive power is a vehicle for some of the most potent and dangerous other liquid and gaseous products.

Liquid elements are unburnt fuel or altered saturated and unsaturated hydrocarbons and water.[4-5-6-7-8-9-10-11-15]

The main gaseous elements are, oxygen, hydrogen, nitrogen, carbon monoxide, carbon dioxide, methane, nitric oxide, nitrogen dioxide, sulphur dioxide and aldehydes. There is also the derivative ozone to consider. Of these, we may ignore as harmless, oxygen, hydrogen, nitrogen, carbon dioxide and methane. Carbon monoxide in sufficient concentration is lethal. In sub-lethal concentration it may produce lassitude and malaise. Sulphur dioxide is a known irritant but nitric oxide, and its derivative nitrogen dioxide, are many times more irritant as are also the aldehydes. The threshold limits for continuous eight-hour exposure to the above substances adopted in America [5] are as follows:—

Carbon Monoxide	100 p.p.m.
Sulphur Dioxide	10 p.p.m.
Nitrogen Oxides	5 p.p.m.
Formaldehyde	5 p.p.m.

Ozone the remaining dangerously irritant and powerfully oxidizing gas has been proven a product of a fairly critical admixture of unburnt fuel oil with nitric oxide.[6-7] In the petrol engine under conditions of deceleration, idling and acceleration it is produced without added NO_2. In atmospheric dilution, by the action of U.V.R. on the unburnt olefins in the presence of NO_2, further ozone is produced. It is irritant in great dilution and the chief cause of smog formation.

The effects of these irritant substances on man when deposited on skin or mucous surfaces (that is externally or internally) are considerable and varied. [9-10-11-13-20]

As is frequently the case, the effect of the oxides of nitrogen was accidently demonstrated in a tragic manner. Some years ago at a clinic in Cleveland, Ohio, men were employed in burning a quantity of used X-ray films. The fumes were irritant, but the men showed no ill effects for two to three days. They then became acutely ill and died suddenly. Death was found to be due to lung blisters, causing suffocative bronchitis as the result of an acute chemical irritant. Experiment revealed that the burning of such films produces copious nitric oxide fumes. (Similar delayed sudden deaths occurred in underground workers using diesel engines). In 1940 the Bureau of Mines in the U.S.A. conducted an investigation and published a report.[8] From this and subsequent work the danger of the oxides of nitrogen became really

apparent.

Apart from the direct irritant properties of these substances, their rôle in the production of ozone has been established.[6] The probability of other associated side effects seems feasible. It may well be that the carcinogenicity of other substances is increased or at least given greater facility to act upon the tissues.[9]

The aldehydes similarly are severe irritants at low atmospheric concentrations. Perhaps of all irritant gases in exhaust fumes, they are the most perceptible to the human being, owing to their marked eye and nasal irritation.

A mixture of oxides of nitrogen and aldehydes is therefore, at low concentration, a chronic irritant to living tissues which requires much thoughtful attention. As we shall see, these are some of the major causes for breakdown in our natural respiratory defences.

In concluding this list of irritants we must now consider 3:4 benzpyrene and other possible carcinogenic substances. These have been very exhaustively studied in recent years by the workers in Los Angeles and elsewhere in the U.S.A.[9-10-11-12-13-20] The production of these by both petrol and diesel engines is confirmed. Comparisons present many difficulties. In the petrol engine both the speed of the engine as well as the load are significant factors.[4-5-10-12-14-15] The diesel engine working under optimum conditions was found to produce no 3:4 benzpyrene at any speed or loading. However, the moment the fuel/air ratio is altered to a richer than normal ratio 3:4 benzpyrene is produced in greater quantities than in the case of the petrol engine. This is of very great importance as we shall see later. The diesel engine emits from ten to one hundred times as much soot as the petrol engine. This soot adsorbs the 3:4 benzpyrene in the atmosphere; therefore adsorbing the petrol-produced as well as diesel-produced carcinogen. In an inefficiently operated diesel engine at 1,200 rpm on full load 1,706 micrograms of benzpyrene were found to be emitted per minute.[11] As an ample quantity of soot is present under such conditions it is likely that the majority of this will be adsorbed.

In studying the ultimate fate of this substance in the atmosphere this adsorption is a significant factor in view of accumulation.

Experiment has proved [12] that when unadsorbed in air, in darkness no destruction occurs. In daylight 22 per cent is destroyed in 48 hours. When adsorbed, only 10 per cent is destroyed in a similar period. Under conditions of smog with aerosols of nitrogen oxides destruction rate is much more rapid. Unadsorbed benzpyrene then shows 50 per cent and adsorbed 18 per cent destruction per hour. The whole question of the ultimate destruction of polycyclic hydrocarbons in air is extremely complex. It has been clearly demonstrated that under varying conditions the carcinogen benzpyrene tends to a slower elimination and therefore may concentrate to values above those found in its primary source of emission. It is certain that its life in air as a pollutant is long enough for it to be inhaled in a period of time at considerable distance from its original source.

Consideration of the physiological and pathological results of acute and chronic irritation by the pollutants of hydrocarbon origin are difficult and as yet incomplete. Acute reactions are due to concentrations in the atmosphere in the order of 100—1,000 times that found in the heavily polluted air of urban atmosphere. Single experimental exposure to the pollutants under consideration at average urban concentrations, individually, has failed to demonstrate any physiological reaction.[13]

Persistent exposure to these concentrations is quite another matter, especially from the carcinogenic angle.[9-10-11-13-14-20]

To mention some of the probable chronic effects on various organs and tissues:—

Skin. The increase in dermatitis and

eczema which is so common today may well be associated with exposure to these pollutants and especially to the regular coating of exposed skin by a film of unburnt petrol or oil. These are well known causes of occupational dermatitis. The blockage of the sweat ducts by soot and oil may cause acne, pustular eruptions or boils. Some persons may be definitely allergic to certain hydrocarbons and who can tell what the effect of constant small doses internally and externally may be on the human body? Is some of the increasing allergy of civilized man due to this cause?

Detergents are well known causative agents in some skin affections. One must also be mindful of their effects in removing the natural fat barrier further to lay the skin open to the attack of other irritants. I feel sure the unburnt hydrocarbons and their products of combustion must be taken into serious consideration for their ultimate effects in this connection. One has only to examine a sheet of glass (which previously has been scrupulously cleaned) after its exposure on a car windscreen driven for 20 miles or so, to realise how much soot coated with oil is present in the atmosphere on our roads. Many of these fluffy carbon soot particles are enclosed in an envelope of oil. This certainly, to our great annoyance, attacks the plating and enamel on our cars, but what thought is given to our own skins?

The Eyes. Lachrymation, or the shedding of tears, is one of the protective mechanisms of the eyes. Solid liquid or gaseous irritants are thereby diluted and washed away. Assistance is given by the massaging action of the eyelids in blinking; an unconscious movement regularly performed thousands of times daily. Exaggeration of both these mechanisms is a reliable indicator of irritant pollutants being present in the atmosphere. The exposure to an urban atmosphere reacts thus on our eyes, increasing the blinking rate and more or less the rate of lachrymation.[7]

Chronic irritation to the conjunctiva covering the eyes and lids produces, according to concentration some degree of inflammation. This is bound to occur when even minimal quantities of oil and soot collect on the moistened surfaces to accumulate on the rims of the eyelids or in the corner of the eye. Some of this solid pollutant, its water soluble parts and oil, are carried into the tear duct and so to the nose. Recurrent infections of this duct are much more common in town dwellers than those in the country. and often cause serious, or perhaps permanent, eye complaints.

The Nose and Upper Air Passages.

The lining membrane of the nose, larynx and windpipe is composed of a delicate mucous membrane provided with minute, hair-like projections called cilia. The function of these is ever to wave in an upward and outward direction, even when we are asleep. Thereby the mucous secretion together with the water as vapour or droplets, both inhaled and exhaled, is constantly brought upwards. Together with this cleansing wash go the majority of all solid and liquid pollutants so trapped. If function is normal past these defences only very minute solid particles may reach the lungs. Some of the resultant waste of this washing ends in the handkerchief, but a larger proportion passes down the gullet and into the stomach from the unconscious acts of swallowing saliva mixed with these dirty secretions.

Unfortunately the pollutants under consideration, or some of them, have a paralytic effect on these cilia, slowing up their action or even arresting it altogether, dependent upon the concentration. This is especially the case with the oxides of nitrogen, aldehydes and their aerosols. The chronic irritation of these, together with the unburnt oil, may set up inflammatory reaction, causing in turn excessive production of mucus and eventually thickening of the membranes. In any case the natural

barrier and cleansing mechanism becomes inefficient to some degree. A state of partial stagnation is created, giving rise to a greater concentration in the passages of trapped pollutants in mucus, setting up what we call catarrh. Nobody can deny how much more prevalent this is nowadays in towns as opposed to country. It also appears more prevalent in the western and wetter areas. Is this because of greater aerosol formation? I feel sure it is.

The sense of smell is undoubtedly dulled or permanently altered as the result of constant exposure to these irritants. This, in turn, makes us all take much less heed of them. After a few weeks holiday, on the hills or at the seaside in remote places, how strongly this strikes one upon return.

The Oesophagus (Gullet) and Stomach.

As we have seen, these organs are bathed with the washings of the upper air passages and indeed from the lungs. They are washed with a concentrate of irritants. It is not unexpected that these may produce mild, chronic, or at times acute inflammatory reaction. This, I think, is not a generally suspected cause of some cases of oesophagitis, or gastritis.

Apart from the above source of irritation, much of the foodstuff we eat raw is exposed to the polluted atmosphere of our roads and cities. Fruit and salads are frequently coated with a film of oil soot before reaching the shop or consumer. At my own home I have an excellent example of this. The market garden situated between my house and the main " A " class road shows gross oil soot coating of the vegetation near the road. The intensity of this progressively decreases yard by yard up this 7 acre field. This soot film is extremely difficult to remove by washing in cold water. On cooking the vegetables especially those grown near the road, a visible oily scum forms and the smell of fuel oil is detected easily in the steam. One wonders how much of this oil and soot we eat?

The Lower Air Passages and Lungs.

The lessening of nature's defences to solid and liquid pollutants in the upper air passages may continue into the lower bronchial tubes and lungs. The soot and aerosols may therefore penetrate in a higher concentration solid matter must be very small. To get into the innermost small bronchioles, and alveolar air spaces in which they terminate, particles of solid matter must be very small. To become engulfed by the dust cells which pass some of the solids into the lymphatic system of the lungs, they must be under 5 microns. Much of the particulate soot derived from oil combustion satisfies this demand. Once in the lymphatics, together with whatever it carries, the soot particle eventually lodges in a lymphatic gland. Smoking, carcinogen and benzpyrene have, for some time, become household topics. It would seem, however, that the benzpyrene derived from tobacco combustion may be trifling in comparison to that found adsorbed in oil soot.[9-10-11-12] There is great significance in this.

One is a little sceptical of skin tumours produced in animals by the repeated painting with carcinogenic extracts. When, however, lung tumours are produced in them by the repeated inhalation of such substances in air, of normal city pollution concentration, the implications are strong. This is more so when the sites and types of tumour are similar to those in human beings.[13]

Benzpyrene is only one carcinogen. Others may be present in the exhaust pollutants, together with, as yet, unidentified substances. It may well be that a combination of carcinogen with non-carcinogenic irritant is needed to cause cancer; and this probably over a considerable period of time.[16] It is the repetitive dose rather than the concentration which counts. No doubt also much depends on the state of nature's defences, individual susceptibility and age. Nevertheless, whatever the answer, enough has already been shown to

establish factual evidence of a very real danger and one that must be lessened, if not arrested.

The practical aspect of arresting this pollution has been much studied in the U.S.A.[21] Various types of after-burners and filters have been investigated. The only promising type that has been produced and is already much used depends on the catalytic action of a white-hot metal alloy covering porcelain grilles through which the exhaust gases are passed.[17-18-19-21] Various problems arise in connection with this as the same type of catalytic filter is not suitable for all types of fuel.

It is fairly simple in the case of non-leaded petrol, but much more difficult with those containing tetra-ethyl lead. Diesel fuel again, though very efficiently treated by such a filter, presents problems connected with varying heat at different engine loadings. These problems are all being investigated and I have no doubt will eventually be solved. The catalytic exhaust filter is almost certain to become the ultimate answer in the destruction of all unwanted agents in exhaust fumes.

It is noteworthy that, of all cancer in man, the biggest increase is shown in cancer of the lung, gullet and upper air passages. This at once points to the fact that the causative agent is most likely inhaled, for we have seen the ultimate fate of pollutants so carried into the body and the implications are grave.

The world needs oil and power from oil has come to stay. Let us therefore be sensible in learning to handle oil in all its uses, with precautions aimed at arresting completely its harmful effects on man.

In conclusion I would like to place on record the valuable and unstinted help afforded me for several years by Mr. Frederick S. Mallette of the American Society of Mechanical Engineers, also Mr. Otis D. Treiber, Consulting Engineer of the Hercules Motor Corporation, Ohio. I am indebted also for recent help from Messrs. Dale H. Hutchison and William C. Theuman of the Stanford Research Institute, California. I am also greatly indebted for the willing co-operation and much valuable data sent to me by Professor Paul Kotin, Professor of Pathology to the University of South California.

Finally, I wish to thank your Executive Council for granting me the honour of presenting this Paper, and the Chairman of your Council, Mr. F. J. Redstone, for his encouragement and help in the preparation thereof.

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Discussion

Dr. A. J. Shinnie said that both speakers had remarked that the particular harmful element in atmospheric pollution was hard to isolate, but that the objective of attack must be filthy air. Dr. Howell had mentioned that there were dangerous factors other than benzpyrene. We should not aim, therefore, simply at trying to reduce the proportion of one constituent in diesel fumes, but at the abolition of dirty air.

Alderman Dr. Sakoschansky (Southampton) agreed with Dr. Lawther's statement that " air pollution is a suspect aetiological factor in the production of bronchitis and lung cancer." Dr. Sakoschansky said that in the previous year he had had occasion to analyse some of the figures relating to deaths from bronchitis in the Registrar-General's Report for 1953.

He had found that the death rate from bronchitis in Devon was 53 per cent. of the national average and therefore the chances of a Devon man dying of bronchitis were half that of Englishmen generally. On the other hand, the death rate from bronchitis in Salford was 230 per cent. of the national average, and the chances of a Salford man dying of bronchitis were four and a half times that of a Devon man.

Some of the figures analysed showed that London Boroughs were bad, such as Camberwell: 211 per cent.; Fulham: 172 per cent.; and Hackney: 166 per cent. Other figures in percentages, were: Wiltshire: 55 (nearly as good as Devon); Plymouth: 65 (the best town on the list); Hants: 77; Bournemouth: 77; Isle of Wight: 89; Sunderland: 95; Liverpool: 97; Southampton: 99; Portsmouth: 129; Manchester: 163.

The speaker felt sure that in the audience those facts would not fall on deaf ears. Somebody would take note of them.

Bronchitis was unfortunately a common disease, but it was a most distressing disease. It often cut a man off in the prime of his life, but it left his intelligence unclouded to the last. It would be a merciful thing to reduce the incidence of the disease.

G. W. Farquharson (Chief Smoke Inspector, City of Birmingham) said that the conference would appreciate the complexity of the research problem, as indicated in the progress reports, and whilst no constituent in smog or even dirty air without fog had yet to be identified as a specific irritant to the human being, they should well consider the stress that Dr. Lawther had made in his paper that " The main answer to the problem is the abolition of air pollution." The abolition of air pollution was the duty of all local authorities and especially those in the so-called black areas. Surely then it was the enforcement by the local authority of the existing law and the future legislation that would be an important factor.

Domestic smoke could be minimized by the creation of smoke control areas. Vehicle pollution called for more vigorous action by the police, and industrial and commercial pollution by the enforcement of the powers given to local authorities.

Mr. Farquharson then quoted figures appertaining to a six months' period of observations on industrial chimneys, showing that, by the service of abatement notices, the average emissions of excessive smoke from 1,037 chimneys had been reduced from 10·67 minutes per 30 minutes observation, to 1·13 minutes, and how, by legal enforcement of the powers given

to the local authority and by magistrates' orders, improvements in plant and reduction of smoke emissions had followed. He maintained that much could be done by enforcement and that advisory action could well be used during the course of legal procedure, and he contended that advisory work in regard to industrial smoke abatement was most effective if brought about through the strength of statutory measures.

D. Lister (County Health Inspector, Northumberland County Council) congratulated Dr. Howell on condensing so much valuable technical information into so little space, and was glad to learn that the research necessary for the solution of the problem was going on. He complained, however, that in the meantime the other aspect of the problem, the emission of visible smoke, was not being tackled, and blamed the inadequacy of the law rather than the fact that the police were alleged to be too busy in other directions. He thought the Society might usefully examine that point in consultation with the police superintendents. Dr. Lawther's bus garage experiments were interesting, but were open to the criticism that they were carried out with vehicles belonging to the L.T.E., whose standard of maintenance was better than the average. Those findings did, however, show the inadvisability of using the lung cancer bogy as a weapon against vehicle smoke, particularly in the absence of any statistics showing an increased incidence of the disease among persons with a higher-than-average exposure to motor fumes. He deplored sensational press treatment of the subject and said that the fact that diesel smoke was unnecessary, objectionable and of no possible benefit to the lungs of those forced to breathe it, was surely sufficient reason for its elimination. In conclusion, he asked Dr. Lawther whether, in view of the presence of CO in tobacco smoke, any of the experiments with the car in London traffic had been carried out with the occupants smoking?

C. H. Crawford (Deputy Public Health Inspector, Brierley Hill Urban District Council) read the following press report from the *County Express*, Stourbridge, 21st April, 1956:

> " Lorry's Cloud of Black Smoke "
>
> " A lorry driven up Brettell Lane towards Brierley Hill threw out such a heavy cloud of smoke black and vapour that a following van ran into the back of the lorry, Supt. W. Crook said at Brierley Hill Court on Thursday.
>
> The accident was seen by a local industrialist, Mr. E. Meese, who is also a Special Constable, and who appreciated the cause of it.
>
> As a result a Manchester lorry driver, Sidney Roberts (35), 10 Pelham Street, Openshaw, was fined £4 by the Stipendiary Magistrate (Mr. Kenneth Wood), on a charge of emitting excessive smoke, etc., from his vehicle. He told Special Constable Meese that he had pump trouble with the engine."

Mr. Crawford added that Mr. Meese was the Chairman of the Amblecote Urban District Council and, because he was a Special Constable, he had been able to take action in that case. That was an example delegates might well follow.

H. I. Fuller (Esso Research Limited) said that there were several items in Dr. Howell's paper that he would like to discuss, but, as time was running short, he would confine himself to one point only. In his paper, Dr. Howell had said that " something has been added in the form of a pollutant which has taken an increasingly significant effect since the early part of the '30's." He said that there Dr. Howell was clearly implicating the diesel engine. Mr. Fuller compared the situation with the introduction of crude mineral oils for lubrication in the cotton industry in the 1870's. As was well known, that led to mule-spinner's cancer—but the disease, previously unknown, did not become apparent until some twenty years later. The idea of a prolonged delay before the onset of symptoms was now familiar in the study of cancer. He mentioned, however, that the interpretation of statistics must be made with great care. As Dr. Lawther had brought out in his paper, for a particular cause of cancer to be considered at all probable, that cause must generally be shown to have existed for some considerable time before cancer became apparent. In that particular case, some cause was indicated which had been operating since much earlier in the 20th century than the 3rd decade.

Mr. Fuller made a plea for more information and less emotion about air pollution, so that responsibility could be placed where it fairly belonged. He did not condone bad operation of diesel engines, but was sure that coal smoke was a vastly greater offender at the present time.

G. C. Smith (Chief Public Health Inspector, Kingston-upon-Thames) said that they must appreciate the foresight of

those who had prepared the conference agenda for an opportunity to discuss the problem of air pollution from road vehicles. Whilst he was not able to comment on the scientific findings of Dr. Howell, he had always been of the opinion that, even in the absence of evidence on that subject, the exhausts from badly maintained diesel engine vehicles could do nobody any good.

He had seen some appalling cases of serious pollution, the most recent having been that of a lorry conveying bricks. An area of two square yards of the face of the bricks which formed the load was blackened. It did not need much imagination to appreciate the extent of the trail of pollution left by the vehicle on its way.

From all that one saw on the roads, the outstanding fact appeared to be the laxity of the police. In November last year a member of the police force had written to a daily paper complaining of the fumes he was forced to endure whilst on traffic duty. He, like most of his fellows, appeared to be ignorant of the police powers in the matter.

Mr. Smith had seen a reference in an Annual Report of a Police Chief that four prosecutions had been taken in respect of nuisance from road vehicles, and, upon inquiring if any difficulty had been encountered in proving the cases, he received the following reply:

> " The wording of the appropriate regulation of the Motor Vehicles (Construction and Use) Regulations is such that, generally, a prosecution requires evidence of a technical nature to conclusively prove the offence. There is not the slightest doubt that it is because of this that prosecutions are relatively rare.
>
> " It is known, however, that the question of an amendment to the Regulations is under consideration and this might well result in a greater number of prosecutions."

Mr. Smith felt that the last paragraph was interesting and he had been informed that the Home Office was not very happy with the present wording of the Regulation. In his opinion, however, the Regulation, as it stood, was workable, and the police could, if they wished, retain or train technical staff to assist in proving their cases. Evidence was also lacking of any informal action that was being taken by the police.

The emphasis, Mr. Smith submitted, should not be laid on the words in italics in Dr. Howell's paper, but on the first part of the Regulation, namely, " the emission of which could be prevented or avoided."

He felt that the Society should do all in its power to rouse public opinion on the emission of exhausts from road vehicles, as much of the work they were doing in other fields would be, to a large extent, nullified. It must be remembered that in most districts that form of pollution was more serious than any other.

Alderman Mrs. Douglas Bolton (London County Council) said that anyone driving uphill behind a diesel engine would accept Dr. Howell's statement that this type of engine produced from 10–100 times as much soot as a petrol engine (particularly the 100 fold). Even if the fumes were less noxious than petrol engine exhaust, they were certainly more nauseating; indeed, it would be interesting to know how many accidents had been caused by motorists taking an all-too-slender chance of passing such a vehicle because they could not stand the diesel exhaust.

It might be that manufacturers of diesel engines, perhaps in collaboration with the D.S.I.R., could design improvements to confine the operation within the non-smoking range, or it might be that the engines could be fitted with exhaust washing appliances. Mrs. Bolton understood that all diesel locomotives in coal mines were fitted with exhaust conditioning boxes and perhaps Dr. Howell would comment on that appliance for heavy goods vehicles.

It was fully understood that the general problems of air pollution were accentuated in a closed space and it might be of interest to quote the L.C.C's experience with the atmosphere in the road tunnels under the Thames. Regular examination was made to ensure that the ventilation supplies in the Thames tunnels was adequate to keep the pollution from gases within acceptable limits, and recently a steady increase in black suspended matter relative to the other pollutants had been recorded. That was attributed to the greater proportion of diesel-engined vehicles in the traffic. It did seem reasonable to attempt to control by regulations the faulty running of diesel engines, and fines might be imposed for smoky exhausts.

Mrs. Bolton also stated she was one of a large number of involuntary consumers of diesel exhausts, and, speaking as a non-technical person, had yet to be convinced that the increased use of diesel engines for transport on road and rail was not a retrograde step. She would like to see more research on electrically propelled

vehicles.

Dr. S. G. Burgess (Scientific Adviser, London County Council) stated that in addition to the pollutants mentioned in Dr. Lawther's paper there was a possible contaminant in this age in the form of radio-active dirt in view of the growing importance of nuclear energy, and that should be borne in mind. Amongst many other aspects of air pollution being examined in the London County Council's laboratories, that matter was receiving attention.

The radioactivity of dust was a difficult matter to assess and the results published by different workers had not shown complete agreement. The amounts varied with atmospheric conditions, the major effects at present being those naturally occurring, although some dust from nuclear weapon tests in distant parts of the world was always present. Dr. Burgess also stated that work was being carried out in the County Hall laboratories to establish the normal levels so as to have a definite basis for comparison with future conditions. It was, of course, necessary to be able to estimate how the radioactivity was made up to detect its source, and he felt their methods enabled that to be done.

G. H. Wilkinson (Chief Public Health Inspector, Corby Urban District Council) said that his Council had for some time been notifying operators of diesel vehicles, which were seen in Corby to be emitting abnormal exhaust fumes, of that fault, and asking for their co-operation in reducing the nuisance. So far his Council had had friendly and co-operative replies to the letters.

Dr. Lawther, in introducing his paper said that it was important to realize that what was called smog in Los Angeles was an exotic lachrymatory haze and contained neither smoke nor fog. It was dangerous to try to apply the results of research on that problem to the totally different conditions obtaining in Britain.

Replying to questions, he said that the criticism of the preliminary results of the diesel bus garage experiments was invalid. It was wise to have begun research in a poorly ventilated garage where there were many well-maintained vehicles belonging to a major user. There were excellent health statistics available on London Transport workers. If the experiments showed there to be no hazard, the standard of maintenance set by London Transport would be a target for other diesel users.

Dr. Lawther told Mr. Lister that the passengers in the car in the carbon monoxide experiment were all non-smokers.

He said he had many criticisms of Dr. Howell's interpretations of the literature but there was not time to deal with more than one particularly important error. Dr. Howell had said that the benzpyrene derived from tobacco was trifling compared to that found adsorbed in oil soot. In fact there were very small amounts of benzpyrene in cigarette smoke and in diesel soot. The smoking of 40 cigarettes per day leads to the inhalation of the same amount of benzpyrene as from the general urban atmosphere in which by far the greatest proportion of benzpyrene came from coal smoke. The amount of benzpyrene inhaled from diesel exhaust was minute compared to that from cigarettes or coal smoke. Dr. Lawther said he was distressed that in their eagerness to blame the diesel engine for the rise in the lung cancer rate people were ignoring the work of Doll and Bradford Hill who had shown an incontrovertible association between smoking habits and the incidence of lung cancer.

Dr. Handley Howell, replying to the discussion, said that Dr. Lawther, in his comments, had emphasized the great atmospheric differences prevailing in Los Angeles and in this country, and disputed the fact that smog, such as occurs in Los Angeles, could occur here. It had not been his intention in his paper to suggest a comparison in that way, as the conditions were obviously so different. At the same time, the effects of inversion occurred in this country at times when we experienced severe fog in cold, anticyclonic weather. The only difference was that we lacked the great contrast in temperature and intensity of U.V.R. Whilst this lessened the occurrence of ozone and its subsequent effects, there was no doubt that this was present in our city atmospheres on those occasions.

Whilst congratulating Dr. Lawther and his team on their research work, he had to state that the tests carried out on two occasions in the L.T.E. Bus Garage were not in any way convincing. One did not expect the emission of any 3:4 benzpyrene, or an appreciable increase of other pollutants to be emitted from 10 per cent. derated diesel in perfect mechanical condition and working under no load.

With regard to the remarks by Dr. A. J. Shinnie and others in connection with isolation of dangerous pollutants, he entirely agreed that the obvious course to

adopt was to eliminate the fumes completely. It must be remembered that the effects of individual pollutants, and indeed all the pollutants collectively, showed great variation. As far as cancer was concerned, it was likely that a combination of certain pollutants, repeated in small doses over a considerable period, was a most dangerous state of affairs.

The remarks of Alderman Dr. Sakoschansky (Southampton) regarding chronic bronchitis brought home the truth of the tragic amount of such in this country. It was agreed, he thought, by all, that this disease certainly predisposed lung cancer, and he had little doubt that the products of the internal combustion engine contributed largely, if not as much, to that state of affairs as the smoke from chimneys.

Mr. H. I. Fuller (Esso Research Ltd.), and Dr. Lawther, had criticized his remarks regarding the change in the 3rd decade of this century, and stressed the point that, to produce cancer, the causative agent must be shown to have existed for a considerable time. Here again they were up against several factors, the susceptibility of the person, chronic respiratory disease such as bronchitis and probably the degree of concentration, together with the time factor. Whereas a person might be exposed for only short periods daily, others might be compelled to breathe the substances into their lungs during the whole 24 hours. Patients who had developed skin cancer after handling crude oil, tar, etc., had, in many cases, done so for relatively short periods of time, others after a great number of years. Again, malignant tumours in the lungs of mice had been produced in a little over a year. It did not therefore follow that one could fix any definite time period for such a condition to develop.

In his remarks on benzpyrene content of diesel fumes, Dr. Lawther considered that the major portion of this substance in urban atmosphere was derived from coal smoke. Other workers had proved that the amounts derived from petrol and diesel engine exhaust, running in maladjustment, were considerable. It seemed, therefore, that the balance of guilt between the two sources must vary considerably, dependent upon traffic concentration and coal-firing in any particular area. This left the whole question open to some doubt.

A factor which had not sufficiently been appreciated in the discussion was that perhaps the most important of all atmospheric pollutants emitted by badly adjusted diesel engines was the soot. This had been proven to be the vehicle for many of the potentially dangerous carcinogenic agents.

The law as it stood did cover that aspect, though for various reasons the police had not pursued the matter energetically. As things stood they were told that there was no immediate likelihood of an alteration in the law, but they must endeavour, by the force of public opinion, to get the present law enforced.

THE WAY TO CLEAN AIR

By

D. P. Welman, M.I.Mech.E., A.M.I.E.E.

The objective of clean air is common ground to all of us at this meeting. We are all agreed what we want: the question is only how we are to get it.

Part of the answer lies in legislation. Through the passing of the Clean Air Act we shall have the means to prevent the emission of smoke, which means in the case of householders, a virtual prohibition on the use of smoky coal. But that is only part of the story. The next step is to decide which of the alternative fuels should take the place of coal.

Electricity and Oil

We have all seen impressive statistical estimates of the phenominal rate of growth which is to take place in electricity and oil supply over the next 10-15 years.

The advance of these fuels is, indeed, likely to be rapid. But so, too, is the rate of advance in the total demand for fuel. With rising living standards more and more energy is placed at the disposal of each one of us, not only at work—but also in our homes.

In fact, these estimates show that in 15 years' time Britain's homes will need an additional 13 million tons of coal (or the equivalent of coal in other fuels) annually. And if we assume that electricity and oil advance at the maximum rate which is reasonably practicable, and double their supply in these 15 years, then they could just manage to provide this extra 13 million tons.

In other words, if we relied on electricity and oil for the expansion of smokeless fuel supply in the next 10-15 years we would probably find at the end of that time that just as much smoke was being poured into the atmosphere from domestic grates as there is at present. All that we would have achieved would have been to prevent the rise in comfort standards from bringing about an increase in the amount of smoke.

The Main Solution—Coke

If we really want to come to grips with this problem of the 19 million tons of smoky coal burnt in household grates in the " black " areas we need the help of all the smokeless fuels. And, in particular, since we are trying to displace a solid fuel used for long-period heating, where low unit cost per therm is more important than rapid adjustment or ease of control

we should preferably find a smokeless solid fuel.

The Beaver Committee examined the possible sources of smokeless solid fuel supply and came to the conclusion that gas coke must provide "the main solution". They set a target for our industry: to replace some 10 million tons of smoky coal in the next 10-15 years, mainly by increased sales of coke.

Can We do it?

How do we view this target? Is it too much for our industry? The answer is clear—there is no reason whatever why we should not produce the required amount of coke during the period stated.

At present the gas industry produces about 10 million tons of coke for sale annually, and if we were to replace one ton of coal by one ton of coke (which would give each consumer 25 per cent more heat in his home than he had before) then we would have to double our output over the next 10-15 years. In fact, this would mean that the gas industry would advance at the same rate during this period as is generally estimated for the progress of electricity and oil in domestic use. (5 per cent per annum). It would be rapid progress—but no more than we actually recorded in the immediate post-war period (1945-51) and there is no reason whatever why we should not be able to achieve it.

But, in practice, our share in the smoke abatement programme could be met with a much smaller rate of production increase. Allowing for the efficiencies with which the fuels are used (as stated in the Ridley Report, Table IV), one half of the heat given by 10 million tons of domestic coal could actually be replaced by 4 million tons of coke, and the other half by 700 million therms of gas.

If we could supply gas and coke on this "half and half" basis then we would be selling the two fuels in the proportion in which they emerge from the carbonizing process and consequently we would need to increase the scale of our carbonizing production by only about 40 per cent over the next 10-15 years. That means an annual rise of production of only 2 per cent, which would represent a very modest rate of progress for an industry that has increased its sales by an average of 4 per cent annually over the past 15 years.

In practice, the annual rate of increase required will probably be somewhere between these two extremes of 2 and 5 per cent—depending on the proportion of coke to gas in the fuel that we sell to replace coal in the smoke control areas. The greater the proportion of coke above the "half and half" mark, the more we should have to increase the scale of our carbonization. But whatever the answer may be, within these limits, it is clear that there is nothing impracticable in the task.

Is There Enough Carbonizing Coal?

If the gas industry can cope quite easily with this programme then what about the coal that it needs to make coke? Will there be enough of that?

This is one of those points where a misunderstanding has been fostered in the process of trying to get people to appreciate an important truth. Of course, it is true that coal is in short supply in this country and we should do our best to economise and to use it most efficiently. That is, in fact, the gas industry's mission in life. It is also true that carbonizing coals, in particular, are scarce and likely to become more so as the better seams of coal are gradually exhausted.

But we must get this problem into its proper perspective. The total annual production of the recognised carbonizing coals in this country is about 130 million tons, or substantially more than half of the total coal output. And of this 130 million tons only about 55 million tons are actually carbonized. The remaining 75 million tons are burned direct on open grates or used for steam raising and a variety of other purposes, all of which would be equally well satisfied by coals unsuitable for carbonization.

The position, therefore, is this. Apart from the coals actually being used in the carbonizing industries to-day there is a further tonnage of carbonizing coals amounting to about one and a half times as much as they are using now. And this additional tonnage is not some vague reserve that might be dug up in future years, but coal actually available here and now—coal, moreover, which is at present being used for purposes where its efficiency in supplying heat is far lower than it would be if it were carbonized.

And even this is not the whole answer. The gas industry, having developed over the years methods for carbonizing these well-established "carbonizing coals" has not been resting on its laurels. We realize that in this competitive world of rival fuel supplies we have to seize every opportunity to cut costs, while maintaining the quality of our product. Consequently, we need to be flexible in the choice of the coals that we process, and we must take advantage of the chance to save money by using the cheaper "non-carbonizing" coals. With this object in view, the industry—and in particular the North Western Gas board—has developed techniques which enable us to use our existing plant to process coals that were not previously regarded as suitable for carbonization: and to do it without offsetting the saving on coal price by lower operating efficiency.

I think it is fair to claim, therefore, that this bogy of shortage of carbonizing coal can be dismissed from our minds in considering the Clean Air Programme. Or, to put it more soberly in the language of the Beaver Committee: "After making due allowance for obstacles . . . ." (i.e. difficulties in redistributing carbonizing coal now used for other purposes) ". . . . it is considered that the coal needed for an expansion of carbonization can be made available." (page 73).

Is Coke Expensive?

One ton of domestic coke in Manchester costs 152/6d. One ton of Group 4 coal, which is the coal most commonly used by householders, costs 133/8d. On the basis of these prices, coke is about 15 shillings per ton cheaper to use than coal. This is not an error in arithmetic but a statement of fact, based on the relative efficiences of the two fuels.

If you burn one ton of coke in a modern grate, of the type which we sell for use with this fuel, you will obtain enough heat to keep your living room warm for 106 days in the winter (15 hours heating each day, at the rate of a 2-bar electric fire). If you burn one ton of coal on the same appliance you obtain only 84 days' heating.

Consequently, to compare the cost of the two fuels you must compare the cost of one ton of coke with the cost of the amount of coal that will give 106 days' heating—namely, $1\frac{1}{4}$ tons. And $1\frac{1}{4}$ tons of Grade 4 coal costs 167/1d. Thus coke, at 152/6d. per ton is 14/7d. cheaper than coal.

Just in case anyone should think that this is some sort of conjuring trick, one may refer again to the Beaver Report. "Coke" says the report (para. 80) "is so much more efficient (than coal) when used with reasonable skill in a suitable appliance that the cost of a useful therm from coke is appreciably less than for house coal." The expression "useful" in this context means the actual amount of heat value delivered to the consumer after allowing for efficiency of burning, and one therm's-worth of such heat is equivalent to a day's heating (15 hours) at the rate of a 2-bar electric fire.

If we refer to the figures in Appendix X of the Beaver Report and bring them up to date to conform with current prices we obtain the following comparison of the cost of a day's heating in Manchester:

Cost per Day's Winter Heating on a modern grate:

Coal

Price per ton (Group 4)	133/8d.
Useful heat content per ton (no. of days' heating)	84
Cost per day	19.1d.

Coke

Price per ton	152/6d.
Useful heat content per ton (no. of days' heating) ..	106
Cost per day	17.3d.

It comes to this, therefore. If you buy coke to provide 106 days' heat (i.e. one ton) then you purchase this amount of heat for 152/6d., or about 10 per cent less than you would have to pay for the same amount of heat in the form of coal ($1\frac{1}{4}$ tons: 167/1d.) Or, to put the same thing differently, for every day's-worth of effective heat actually delivered into your home you pay 17.3 pence if it is taken in the form of coke, which is about 10 per cent less than you would have to pay if you took it in the form of coal (19.1 pence).

The Appliance

Coke is an efficient fuel because the smoke-producing substances, which cannot be efficiently burned in an open fire, have been removed from it. But if you place a pile of coke on the ground and put a match to it you will find that this high-efficiency fuel gives a very low-efficiency service.

This is more or less what happens if you burn coke in an old-fashioned grate where no effective control of the air-flow to the fire is provided. What is needed is a modern grate in which the air current under the fire is directed at the point where it can efficiently sustain the process of burning. Preferably, also, there should be some controlled restriction of the chimney aperture to regulate the overall volume of the air flow.

The installation of a modern grate of this kind is a very simple matter and most of the houses built by local authorities since the war have in fact been fitted with grates that measure up to the standard required. The problem in the smoke control areas will be to persuade householders in the older houses to install these appliances. But here again, there has been a tendency to exaggerate the difficulties that may arise. In the North Western Area we have been installing grates at the rate of about 10,000 a year and judging by the very flourishing condition of the trade among ironmongers and heating concerns, these firms have probably succeeded in selling a still larger number.

The cost of an efficient coke grate complete with gas ignition is about £5 12s. 0d. and the consumer who changes over from an old-fashioned coal fire to this appliance can save the whole cost on his fuel bill in one year. But even apart from any compensating fuel saving this is surely a very small gnat to swallow in relation to the benefits of smoke abatement and the comfort and cleanliness offered by coke burning and when we consider that such a grate with all its trimmings, can be acquired on hire purchase with a deposit of 12 shillings and 11 quarterly payments of 10s. 10d. then, surely, we must agree that in this age of mass markets for television sets and holidays abroad, the fuss that has been made over the difficulties entailed in converting appliances to efficient smokeless fuel burning is really quite unnecessary.

There are, of course, hard cases where either the poverty of the householder or the poor condition of the existing fireplace may make conversion difficult. But for these cases we have the machinery of assistance by the local authority—supported by the Treasury—and where the conversion is compulsory it is only right that such help should be given. In general, however, we need not fear that either as individuals or as taxpayers we will be saddled with any crushing burdens through the conversion of the 7 million open grates in the " black " areas.

Making Better Fuel

" Coke " is, of course, a broad term; like " coal " or " cheese " it covers a wide variety of products, some of them desirable and others less so.

" When we speak of coke, " said the Beaver Committee, " we mean a high quality free-burning fuel that will be completely satisfactory to the domestic consumer when used in

modern appliances." And then: "We have seen areas where such coke is provided and used with full satisfaction. A great deal of the coke now produced, however, is not of this quality and measures must be taken to provide an improved fuel . . . ."

This is a quotation from the Beaver Report, but it might well have been a quotation from one of the internal memoranda of the North Western Gas Board some two or three years ago—and no doubt it will be equally true of other Areas as well. There is a tremendous drive in progress throughout the industry to obtain the high and consistent standard of quality which the Beaver Committee established as our target. This drive has been necessary because the gas industry is after all primarily a **gas** industry, and until the emphasis changed with the Clean Air Programme our production and selling policy was mainly geared to the gaseous product. But now we are on the move, and we are determined to satisfy the requirements of this new market that has been opened up for us.

The main requirement for an open fire fuel is "burnability" or "free-burning" as the Beaver Committee called it. The fire must reach a cheerful glowing stage rapidly after lighting and it must pick up quickly after being recharged. This is not as easy to achieve with coke as with coal. But there are various ways of tackling this problem and we have made headway with all of them.

By choosing coals for carbonization which are themselves more easily "burnable"—such as those from the Scottish and East Midland coalfields—we obtain a coke with an open porous structure which is highly "burnable" By careful supervision of the carbonizing process in order to prevent excessive "cooking" of the coal we retain the reactive properties in the coke which allow it to burn freely. By the installation of efficient coke screening plant and by making the fullest use of such plant we secure a uniformity of grading within the sizes required for open fires (2″ x 1″) which ensures the maintenance of a satisfactory air flow through the fuel bed and thereby again substantially improving the burning quality of the fuel.

Progress in all these directions is carefully supervised and for some time now regular sampling of coke production to examine not only the burning characteristics, but also the general quality of the coke in a wider sense (ash and moisture content, shale, etc.), has been the practice in the North Western Area. Similar procedures are in force elsewhere. The results of these tests are related to the type of coal used and the method of plant operation at the point where the coke was produced, and—within the inevitable limitations of choice of coal qualities available to us—we are applying the lessons from this information directly to our coal purchasing and production policy.

On the marketing side, we have introduced a scheme of incentives for merchants who provide a high standard of technical advice and service to the consumer. Within our own organization we are giving increasing attention to the training of staff to advise and assist the consumer in all aspects of satisfactory coke burning. Collaboration between our undertakings and the local authorities in the "black" areas is very close and cordial, and both sides are conscious of working towards a common aim.

While it will no doubt be most encouraging to everyone to feel that the gas industry is doing everything in its power to raise coke to a point of maximum efficiency as an open grate fuel, and to ensure that it shall arrive in the consumers' cellar consistent in size and quality, we must still ask ourselves whether we have in coke the ideal smokeless fuel.

It is true that with the exception of certain patent fuels, the maximum output for which is limited by the source of raw materials and similar circumstances, coke is indeed at the moment the only solid smokeless fuel

available to us in sufficient quantity for our major task of cleaning up the atmosphere. It is, moreover, a highly efficient fuel from an economic standpoint when properly burnt in suitable appliances.

Given the availability of a sufficient quantity of good quality coke, therefore, clean air could be achieved very rapidly through legislation and the subsidizing of suitable appliances where necessary, but quite obviously the ideal approach to this important problem would be found if we could offer to the public for use in the open grate a completely smokeless fuel which had all the advantages of coal in ease of ignition and psychological comfort, without any of its serious disadvantages both to the housewife and to the country, which arise from its smoke characteristics.

With this in mind, therefore, the North Western Gas Board laid down a specification for an ideal fuel some three years ago, and concentrated their technical efforts in developing a fuel which would satisfy that specification.

The properties laid down for this ideal fuel were:

(1) That the fire should be capable of being kindled using paper and sticks, a firelighter, or a gas poker, as easily or more easily than would be the case with good quality coal, and that this ready ignition should be capable of easy achievement in *any kind* of firegrate.

(2) That the fire once kindled should rapidly achieve its full heat output, and maintain that output without frequent attention.

(3) That once the newly lighted fire had reached normal burning condition, its appearance should be such as to give the same psychological satisfaction as can be obtained from the coal fire using good quality coal—a matter which is still, and is likely to remain for some time, of considerable domestic importance.
This demands that when giving full heat output the fire should not have a fierce appearance, and should burn with a satisfying cheerful flame.

(4) That the fuel itself should burn equally freely and satisfactorily, irrespective of the size of the pieces.
This requirement is important in order to obviate the disadvantages of the slack that accumulates from coal in handling in the cellar, and which can normally be used only for banking up conditions at night.

(5) That the fuel itself should be completely clean to handle so that a domestic fire could be stoked if necessary without a shovel or tongs.

(6) Finally, that the fuel should be absolutely smokeless in use.

It will be seen that the full requirements of this specification, taken together, cannot be found at the present time in any type of solid fuel at present available.

So successful has been our attack on this problem that the Board are now producing two fuels which they have called " Thermalite " and " Thermax "

The first named completely satisfies in every respect the specification outlined above, and has already been brought from the pilot stage to full stage production. The board feel that " Thermalite " can and will offer one of the greatest advances yet made in the campaign for clean air, and will satisfy in the fullest measure the objectives of the Beaver Committee.

It should be remembered that there are probably up to 10 million houses in the country as a whole which still have a considerable number of years of useful life before them, but which are unlikely for a variety of reasons to be provided at any time in the future with special coke burning appliances. For such homes " Thermalite " provides an immediate answer without

capital outlay on the part of the householder.

" Thermax " is a somewhat different fuel, having high density in addition to ready ignition and long-burning characteristics. This fuel is likely to prove ideal for the closed or openable stove, the solid fuel cooker, and for the provision of hot water and central heating. It is also readily ignitable and entirely suitable for use in the open grate though, unlike " Thermalite ", it presents a somewhat uniform appearance.

While it is not proposed to introduce " Thermax " to the market immediately, it is hoped on the other hand that " Thermalite " may be available to the market in quantity during the coming winter.

Conclusion

To sum up. Briefly, it comes to this. We in the gas industry have a very important part to play in the provision of smokeless air that cannot be met by electricity and oil. There is no technical obstacle in the equipment of our industry to prevent our meeting the demand; and there is no lack of suitable coal with which to do it. The price of our coke is fully competitive with coal and the cost of the necessary appliance is small in relation to the benefits which the consumer and society in general will derive from coke burning. The quality of our coke is being steadily improved and new fuels are being developed to meet the special need of the ordinary open grate.

On behalf of the North Western Gas Board, therefore, and also on behalf of the industry as a whole, I would say to this conference: Go ahead—as fast as administrative processes and human considerations will allow. Give us the zones, and we will supply them.

DEVELOPMENTS IN THE PRODUCTION OF SOLID SMOKELESS FUEL

By

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The report of the Beaver Committee on air pollution, the essential features of which have now been embodied in the Clean Air Act, laid emphasis on the amount of smoke that is produced by domestic chimneys. Although, according to their figures, more than half the total amount of smoke in this country is produced by industry, domestic chimneys produce more than twice as much smoke per ton of coal burnt; moreover, this smoke is discharged into the air at a low level, where its harmful effects are accentuated. No cure can, therefore, be found for the heavy smoke pollution of our cities and towns until the domestic chimneys are adequately dealt with. The Committee recommended that within a space of 10 to 15 years the 19 million tons of bituminous coal per year burnt domestically in the " black " areas should be replaced by the equivalent amount of smokeless fuels, and for this purpose they defined that coal containing not more than 20 per cent of volatile matter could be regarded as smokeless. Apart from this arbitrary criterion, the Committee gave no definition for smokeless fuels,

but it is clear that, in addition to electricity, gas, and low-volatile coal the term may be taken to include all sorts of coke and manufactured carbonized solid fuels.

The introduction of this new policy will give the National Coal Board two main tasks to carry out. The first of these is to arrange that the large quantities of bituminous coal displaced from the smokeless areas are made available for conversion into electricity, gas, coke, or other types of manufactured smokeless fuel. The second is to increase their own production of manufactured smokeless fuels, and this will call for a vigorous development programme to translate into commercial production the results of the research work at the Board's Research Establishments and other establishments.

In order to see where all this smokeless fuel is going to come from, the existing coal supply position must first be examined. The fact that emerges at once is that coal of all types is going to be in short supply for quite a few years to come, mainly because of the apparently insatiable demand for electricity: in this country, as in many others, this demand appears to double itself every ten years, and there is absolutely no sign of slackening off. The second fact is that although this country is fortunate in possessing very large reserves of coal, ranging from anthracites to high volatile coals, the bulk of the reserves consist of types that are not naturally smokeless. And any supplies of coal that may, in the long run, be made available when the extra supplies of electricity generated by atomic power have overtaken the increased demands will also be of this type.

The Smokeless Fuels

The natural smokeless fuels falling within the definition adopted by the Beaver Committee are anthracite, dry steam coals, and coking steam coals with volatile content not exceeding 20 per cent. By far the largest part of the output of these coals comes from the South Wales coalfield, with smaller amounts from Scotland and Kent. The Board are sinking two new anthracite pits and plan to increase the production of anthracite in South Wales to 4 million tons a year. In ten years' time an additional three-quarters of a million tons a year of anthracite may be available for the domestic market, together with a similar increase in the output of dry steam coal: these figures are small compared with the Beaver Committee's estimated requirement of 14 million tons of smokeless fuels and in any case, apart from their cost, these fuels are only suitable for closed appliances, and in the case of dry steam coals, for burning in bar type open grates, with adequate draught.

The manufactured smokeless fuels include oven coke, gas coke, low-temperature coke, and other carbonized fuels. Gas coke, which is at present the most important smokeless fuel, is outside the province of the National Coal Board: the annual domestic consumption is about 2.7 million tons. Practically the whole of the coke from coke ovens burnt domestically—about one-third of a million tons a year—is produced in N.C.B. ovens. Two low-temperature cokes are available at present, Coalite and Rexco, both suitable for use in open grates. The last of the existing types of manufactured smokeless fuel is Phurnacite, a specialized premium fuel intended to cater for the same markets as anthracite nuts, and not particularly suitable for use in open appliances.

The increased amounts of smokeless fuels envisaged by the Beaver Committee can be produced only in part by expanding the production of these manufactured fuels along the same lines as heretofore. All existing carbonization processes are selective, not only in the rank of coal they require, but also in the size, ash content, sulphur content, and other factors. Conventional gas making, for instance, requires coals which give good yields of gas of high calorific value and a coke

strong enough to stand up to handling and to transport; and if this coke is to be burnt with satisfaction in open grates it must be reactive and have a low content of ash. Good coking coals, also, are in increasing demand for the manufacture of metallurgical coke, and so attempts are being made to extend the range of coals that can be used for coke manufacture. The most direct way of doing this is by blending the coking coals with other low-rank coals before they are charged to the coke ovens, and blend compositions and coking conditions can be worked out in advance from laboratory tests including measurements of viscosity of the blends in the plastic range, followed by pilot plant tests.

The coal from which Coalite is made is also suitable for the manufacture of gas, so in considering the question of expanding supplies the rival claims of the gas industry have to be borne in mind. Rexco is made from coals of lower rank, and although the requirements are rather narrow, production of coals of this type is likely to increase in the future. Even so, substantial increases in the production of Coalite and Rexco are in hand.

Phurnacite represents the ideal type of smokeless fuel for closed appliances, since it consists of lumps which are uniform in size, shape, and properties, and a fuel of similar type for use in open appliances would obviously be attractive. In the Phurnacite process fine dry-steam coal mixed with pitch is pressed into briquettes which are then carbonized in ovens. Unfortunately, the range of coals that can be used in this process is small, and these coals are not very plentiful now nor likely to be so in the future. The Phurnacite plant is located at Aberaman, in South Wales, and further expansion of the output is limited by the availability of suitable dry-steam coals in the Aberdare area and by the distance of the plant from the potential markets of the Midlands and the North of England.

The major output of coal in this country is shifting all the time towards the coals of lower rank and higher volatile content, and although the Phurnacite process could be expanded to a limited extent within the range of suitable coals, any attempt to produce smokeless fuels on the scale required for open-grate fuels—that is, up to 14 million tons a year— will be obliged to start with these high-volatile coals as raw material. When the Phurnacite process is applied to other types of coal, the briquettes either swell and flow into a solid mass or crumble and fall to pieces. In an attempt to extend the range of coals that can be used, however, it has been found that a Kent coal fairly similar to the South Wales coking steam coals and the latter coals themselves can be made suitable for this treatment by a mild oxidation process which reduces their fluidity and agglutination index.

Oxidation Process

This oxidation process has been developed to the pilot-plant scale at the Board's Coal Research Establishment, at Stoke Orchard near Cheltenham, with a throughput of about 1 ton per hour. The oxidation is carried out in a fluidized-bed reactor, using a technique developed in the petroleum industry. In this process hot air or hot gas is bubbled through a bed of finely powdered coal until the coal particles are suspended in the stream, giving the appearance of a boiling fluid. The plant is fitted with automatic control of the bed temperature and safety devices for shutting it down in the event of a failure. The resulting oxidised coal follows the normal procedure in the Phurnacite process, and gives briquettes of high quality.

The coal emerges from the oxidizer at a temperature above 375°C., and briquetting is normally carried out at 80°C.: it seems a pity to cool the oxidized coal down for briquetting only to heat it up again in the subsequent carbonization stage. A process of briquetting at high temperature, without intermediate cooling, is therefore being developed at Stoke

Orchard, and in addition to saving heat this process has been found to require less binder for the production of satisfactory briquettes, with a consequent reduction in costs.

In the third stage, the carbonizing of briquettes, the major problem is one of heat transfer, since both coal and coke are poor conductors of heat. As a result of this, the carbonization of coal in coke ovens may take up to 15 hours or more, and in gas-works retorts rather more than 6 hours. Research has been carried out at Stoke Orchard into possible methods of overcoming this difficulty. One method tried is that of introducing the heat to the briquettes at a sufficiently high rate by causing hot sand to pass over them as they descend through a cylindrical chamber. In this way, it has been shown that the carbonizing time can be reduced to a quarter or less of that normally required in indirectly heated narrow retorts, i.e. to about one hour.

The oxidation process which has been described is not suitable for the treatment of low-rank coals in order to make them suitable for the manufacture of carbonized briquettes, since the resulting briquettes tend to be weak and fissured. It has been shown, however, that if some low-rank coals are briquetted with a modified binder, to which certain inexpensive chemicals have been added, the briquettes can be carbonized directly without distortion or fissuring. The carbonization of low-rank coals yields large quantities of tar, some of which, suitably modified, could probably be used in this process to make it self-supporting in binder requirements.

Fluidized Carbonization

A process of fluidized carbonization has been evolved for these low-rank coals which enables the carbonization again to be completed in a short time. Various methods of heating the fluidized bed can be employed, such as the use of air or a mixture of air and steam as the fluidizing gas, or of hydrogen under under pressure. This last method can be used for the manufacture of town's gas, and is being studied by the Gas Council. The method adopted at Stoke Orchard is to withdraw part of the char from the main reactor to another chamber, where it is partially burnt (again in the fluidized state), and then return the reheated char to the main reactor.

Although the fluidized bed technique is used on a very large scale in the oil industry, its application to coal carbonization is by no means straightforward: in particular, the problems of separating and removing a solid product have not had to be faced in the oil industry, and many formidable obstacles, such as the carry-over of dust and the separation of this dust from the tar, remain to be overcome.

The products from these processes are closed-stove fuels, for which there is a limited demand at present, but it is hoped that by adjusting the conditions of carbonizing an open-fire fuel can be produced. All these stages of treatment naturally involve extra cost, and although the resulting fuels are in every case capable of giving higher efficiency in use than the original bituminous coals, the domestic consumer has yet to be convinced that they are worth paying a higher price for. Since all these processes yield large quantities of liquid by-products—in some cases over 30 gallons per ton of coal—the economics of the processes must be decided largely, if not entirely, by the use that can be made of these by-products and by the price that they will be able to command on the market. The products are in general of a primary tar nature, having suffered less decomposition than the products of conventional carbonization processes, and are therefore on the whole of a higher boiling range. Methods of cracking and hydrogenation are being investigated with a view to producing raw materials and intermediates from these high-boiling derivatives which will be more immediately attractive to the chemical industry.

In all conventional briquetting processes, pitch is used as the binder: for this purpose it is not ideal, for although

it is a good binder, it is expensive and smoke-producing. Research over many years has failed to reveal a really satisfactory substitute. Briquetting without a binder is possible with very soft coal—for instance, the brown coal of Germany—but with ordinary bituminous coals the pressures required are very high, and the many processes put forward have all proved to be uneconomic in operation. A new process of binderless briquetting is now being developed at Stoke Orchard: this process is based on an entirely new principle, in which the briquette is distorted while it is under pressure in a press, thus causing the coal particles to cohere more effectively; as a result only about half the normal pressure used in the direct briquetting of brown coal is required. The process can be applied to all types of coal except anthracite, and its development may open up extensive possibilities. For instance, it should be possible to briquette high-rank coal fines to produce directly a smokeless lump fuel; and bituminous coals could be made into briquettes for burning in areas where smoke emission is not controlled, or these briquettes could be carbonized to form a smokeless fuel, or, perhaps, a metallurgical coke.

Discussion

Dr. G. E. Foxwell (Institute of Fuel), in opening the discussion said that the two authors of the papers just introduced had spoken of work that was already in progress or was projected. He did not think that the conference would benefit from a discussion of the techniques of production, but it would be valuable to have the reactions of local authorities to some of the proposals at present being made by the fuel producing industries. He thought it was very important to come to a decision about our national domestic heating policy. He had suggested in other places that hitherto it had been our policy to employ very inefficient appliances, which wasted a great deal of fuel, to provide only a small warmed area round the fire. One of the papers had indicated that a very reactive grade of coke would be marketed, similar to the low temperature cokes now on the market, which could be burnt on existing grates. It would then, it was suggested, be unnecessary to install the new appliances envisaged in the Act. He thought that this would, in general, be a retrograde step because it would perpetuate our inefficient methods of heating. Premises existed, however, which had been scheduled for demolition in the near future, and others that had no gas supply and in which gas-ignition was not possible. Here it would be necessary to use existing grates, and they would provide the logical outlet for the very reactive fuels. Here would be a market, too, for those very reactive fuels; some householders would pay more for a trouble-free fuel.

Dr. Foxwell went on to say that when the Beaver Committee spoke of future coke as a "high-quality, free-burning fuel, completely satisfactory to the domestic consumer," they were thinking of an improved type of high-temperature coke. With improved methods of coke preparation by screening, the building of more vertical retorts in place of static plants, and the diversion of vertical retort coke to the special markets of the smoke control areas, it was felt that the gas industry could do much to meet the changed pattern of demand.

Whilst solid fuels, burnt in modern appliances, could take the main winter space-heating loads, the gas produced as a result of extra coke production, together with the other refined fuels, could be used economically and efficiently for water-heating and intermittent space heating—bedrooms, short-period and spring, summer, or autumn main heating. From a combination of methods, a much better heating service could be obtained than most people had enjoyed in the past, at little extra cost.

He said that it would be of considerable interest to hear the reactions of local authorities to the increased cost of the new smokeless fuels, which would possibly cost 30s. a ton more than coal, but would be far more satisfactory in operation. People today asked for convenience and smokelessness, but it was sometimes forgotten that we had to pay for better

quality, whether in materials or service. He hoped the local authority speakers would consider the proposals here made by the fuel industries and say what snags they foresaw when smoke control was being set up. In a number of smoke control areas, continuous vertical retort coke made from medium rank coal had proved very satisfactory when burnt in a modern coke burning grate, provided the householder was first shown how to use the new appliance.

Dr. Foxwell concluded by saying that he wanted to propose for discussion the question: do we need more very reactive fuels, or just another better high temperature coke, or were we satisfied with the existing products?

A. C. Hazel (Hurseal Ltd.) stated that he felt that Mr. Welman had overemphasized the case for the coke grate and it was important that representatives of local authorities attending the conference should realize that there were now on the market new appliances whose efficiency was double that of the coke grate.

Indeed Dr. Foxwell who had just spoken had had an excellent article published in *The Times* only the day before in which he drew attention to these free-standing fires with restricted throats which provide a higher standard of heat comfort with about half the fuel consumption.

On that basis Mr. Welman could have strengthened his case by demonstrating that instead of heating a room adequately at a cost, according to his calculations, 1s. 7d. per day, his figure could have been less than 1s. per day.

The second point which Mr. Hazel wished to make was on the great need for flexibility. Here again, Mr. Welman had drawn attention to the new smokeless fuels. Mr. Hazel wanted to make the point that whatever fuel and whatever the appliance, it was absolutely vital in a climate such as ours that the fire or space heater could, on very cold days, produce a great deal of heat, but on mild days could be turned, in the case of a gas or electric appliance, as low as possible, and in the case of solid fuel appliances, so that the fire just slumbered.

Alternatively, in the case of the solid fuel appliance, it should be capable of quick ignition so that it could be used for three or four hours with a very small fuel consumption.

His third point was that there was a need for efficiency. Mr. Hazel said that the word " efficiency " was conspicuous by its absence from the various papers but Dr. Idris Jones, in his remarks that afternoon, had drawn attention to the fact that the Suez crisis had again emphasized the great need for efficiency. It therefore followed, Mr. Hazel said, that whatever the type of appliance it should be the most efficient possible. It was true to say that whatever the appliance, be it gas, electric, paraffin or solid fuel, if it provided its heat in the form of radiation and convection and reduced room draughts to a minimum, then it was much more efficient than a gas, electric or open fire providing its heat largely in the form of radiation.

The key to the domestic heating problem therefore was providing only those appliances which provided radiation and convection which were exceedingly flexible in operation and which had the highest possible efficiency. By taking these simple steps we could use our smokeless fuel supplies in the most economical manner possible.

F. L. Waring (Coalite and Chemical Products Limited) referred to the papers by Mr. Welman and Dr. Idris Jones. As was well known, he was a " hot gospeller " for the retention of the open fire and in his view it would be a great tragedy if it was lost to this country. He welcomed the recruits to the fold. There was a national affection for the cheerful and psychologically desirable open fire which was part of our heritage. If we were to retain the open fire in the light of the imperative need for cleaner air and improved efficiency, one had to have a suitable smokeless fuel. Mr. Welman detailed six properties of what he described as the ideal fuel should have, and which formed the basis of a specification that had been adopted as the target of his Board several years previously. Whilst agreeing implicitly with requirements of the ideal fuel as set out in the paper, he said that he must take exception to the statement that these, when taken together, cannot be found at the present time in any type of solid fuel at present available. He was surprised and disappointed that Mr. Welman had apparently not heard of " Coalite." He was sure that many satisfied consumers in the hall would agree with him that " Coalite " met the specification in full.

Dr. Idris Jones had suggested that coal from which " Coalite " was made was also suitable for the manufacture of gas, and when considering the question of expanding supplies the rival claims of the

gas industry have to be borne in mind. He pointed out that "Coalite" was produced from small coal which was not generally used for carbonization at the average gas works. Further, a large part of the coal used was not sufficiently strongly caking to be normally acceptable for high temperature processes.

J. W. Moule (South of Scotland Electricity Board), speaking on Mr. Welman's paper, said that everyone recognized the problem of producing adequate quantities of solid smokeless fuel, if indeed solid fuel were to continue to be the principal fuel for the heating of dwellings. Mr. Moule pointed out that on page 14 of his paper, Mr. Welman had commenced a line of reasoning on the assumption that electricity doubled its sales in fifteen years. That was incorrect and Dr. Idris Jones was much nearer the mark when he referred to electricity consumption as doubling itself every ten years. If Mr. Welman's line of reasoning were adjusted to reflect the more accurate figure of expansion in electricity sales, it would be found that, not only would electricity and oil have provided the equivalent of an additional 13 million tons of fuel during the next fifteen years, but they would also have bitten very deeply into the 19 million tons of smokey coal at present burned in household grates in the black areas.

In his conclusion Mr. Welman had said that the gas industry had an important part to play in the provision of smokeless air that could not be met by electricity and oil. Electricity also had an important part to play in the matter and the advent of the nuclear generating station pointed to the fact that electricity would be the fuel of the future and would soon be in the best of positions to meet extra demands which would arise from the needs of the smokeless areas. In Scotland the Atomic Energy's Chapelcross nuclear generating plant would be brought into operation in two or three years' time and in about five years the Board hoped to commission their own Ayrshire nuclear generating station. Those two stations between them would save between 1 and 1½ million tons of coal per annum, the significance of which was emphasized when it was remembered that, at the present time, about three million tons of coal were burned in the South of Scotland Board's electricity generating stations. Those figures should not be taken as representative of the whole of Great Britain where the proportion of generating plant in relation to the capacity of coal fired generating plant was much less.

Finally Mr. Moule drew attention to the special steps that were being taken to burn slurry from colliery washeries in generating stations. That all pointed to the major contribution Electricity Boards were making to the best possible utilization of fuel.

H. V. Cass (C.P.H.I., Oldham) congratulated the North Western Gas Board and Mr. Welman on the two new fuels: "Thermax" and "Thermalite." As Chairman of the North West Divisional Council of the Society, he had tried them, and "Thermalite" had immediately overcome his wife's prejudice against coke. It seemed to possess all the good points mentioned by Mr. Welman in his paper. It could be lit easily with wood and paper, but did not over-heat, giving the stifling atmosphere sometimes experienced when a coke fire was used in a badly ventilated room. Since the fuel could be burnt in an ordinary stool-bottom grate, he thought it would help the ordinary man in the street to comply with the proposals for smoke control areas without difficulty. The only important question at issue was the price. Although "Coalite" was an excellent fuel, he hoped that "Thermalite" would be sold at a price which would enable it to compete strongly with "Coalite."

He had also tried "Thermax," and had found it to be clean to handle, long-lasting and to burn without waste. He had one criticism, however; it was extremely difficult to ignite, even with gas ignition.

He wanted to make it quite clear that he was in no way sponsoring these two fuels, or showing favour to the Gas Board, but he thought it important to mention the conclusions to which he had come after trial.

Councillor W. A. N. Jones (Birmingham) made reference to the difficulty large local authorities had in convincing thousands of very ordinary householders that they must, as and when smoke control areas come into being, burn only smokeless fuel. That fuel at present could only be burnt successfully in specially constructed grates.

Surely, he said, what they needed was a fuel which could be burnt smokelessly in any type of grate, and at a price which would enable it to be purchased without any hardship by those with the smallest purse. Most of them were still puzzled at the higher price of coke in comparison

with raw coals; and people thought that the many by-products, gas not being the least, should at least bring sufficient financial return to enable coke to be sold at a more favourable price. It seemed that they now had commercial interests entering into the need for clean air. The Coal Board and Gas Boards versus the private manufacturers of smokeless fuels. He hoped that between them an ideal solid fuel would result.

People were also puzzled as to the best appliance at the right price. At present too many firms claimed to manufacture the best. The approved appliances should be reduced to about five or six, to suit different tastes in design, colouring and price.

Councillor Jones concluded by saying that when they had sorted those problems out then they would start to convert more people to the Society's ideals and purpose.

N. Bastable (C.P.H.I., Barking) said that he wished to deal with one important aspect of the problem which had not so far received any attention in the discussion.

He reminded the conference that all the emphasis was being placed upon the production of new smokeless fuels, particularly reactive coke. He thought it most unfortunate that the conference had not been addressed by representatives of the distributors because here was the key position. In his experience the most difficult period so far as smokeless zones were concerned occurred during the peak cold months of January, February and March. He had, reluctantly, to say that the distributors' organization methods and vehicles had not been brought up to date and that at the worst period of winter proved inadequate. Without the closest liaison between production and distribution there would be a breakdown in smokeless zones.

He invited the Executive Council to endeavour to get a speaker from the distribution side at the next Annual Conference.

S. N. Duguid (Individual Member) said that they had been asked what kind of smokeless fuel the householder required. The answer was easy. He desired a solid smokeless fuel as good as coal and at the same price or cheaper.

He said that he had some knowledge of the meaning of the term "British Thermal Unit," and could follow and agree with Mr. Welman's figures by which he endeavoured to prove that coke was cheaper than coal, but that argument would never be accepted by the vast majority of housewives. Factors other than heat values had to be taken into consideration when making a comparison between coal and coke. For example, points should be knocked off the value of coke for the extra storage capacity it needed, gas ignition and the difficulty of keeping a coke-burning appliance tidy. If a cash value could be put on it, then a fair relative price for coke might be about 80 per cent. that of coal. When coal had been raised by 6s. per ton recently, the price of coke had advanced by 9s. No argument would ever convince the coke user that the relative increase was justifiable, particularly if he was old enough to remember the days when coke was much cheaper than coal. The high price of coke relative to that of coal was one of the greatest stumbling blocks to the voluntary adoption of coke for coal. If an adequate quantity of solid smokeless fuel was to be made available during the next few years, he thought it might be necessary for our collieries to become producers on a large scale and so supplement the efforts of gas works and private concerns.

Mr. Duguid said that we ought to take a leaf out of the book of the Water Engineer. He did not send out water-laden with germs and tell us to kill them ourselves, but removed all offensive matter before the water got to the user. Collieries please copy.

Dr. Idris Jones agreed with Dr. Foxwell's observations concerning the undesirability of perpetuating the use of inefficient existing grates. Even the best smokeless open grate fuels used in old-fashioned open grates did not give an efficiency comparable with what was attainable with modern closed appliances.

Reactive smokeless fuels, such as Cleanglow, required the use of lump coals of specific characteristics and these were in short supply. On the contrary, more and more small coal especially of high volatile content was being produced. The various briquetting processes now being evolved by the National Coal Board at Stoke Orchard provided a solution to the three problems of reducing the importation of large coal, converting small coal into large coal and producing really efficient smokeless domestic fuels.

Another important point made by Dr. Foxwell was that making these new fuels cost money, but this might be well-spent money, and justify higher fuel prices in virtue of their enhanced available heat

content and special characteristics. The important thing that mattered to an ordinary householder was not the price per ton of solid fuel, but the total fuel bill per annum. In reply to Dr. Foxwell's query as to whether they needed more very reactive fuels or just another better high temperature coke, it might be of interest to refer to the work that the National Coal Board are now carrying out in Yorkshire. This work had shown that a reactive fuel, very acceptable in ignitability, combustibility and other respects by the domestic householder, could be made at high temperatures in narrow coke ovens.

Dr. Jones said he was in full agreement with Mr. Hazel's observations as to the need for flexibility as well as efficiency in these fuels.

He supported Mr. Hodson *apropos* Mr. Moule's reference to electricity as the fuel of the future. There was no doubt, of course, that the use of electricity would increase but it would always be more expensive for continuous space heating than solid smokeless fuel especially when this was burnt in modern appliances. There was also the long discussed peak load generation problem with consequential heavy capital expenditure in power plant to contend with.

Finally he endorsed Mr. Duguid's observation that they should follow the Water Engineers' example and remove the offensive matter in their fuels before it got to the user. Considerably more money had been spent on water purification and aqueous effluent treatment than on the production of solid smokeless fuels.

Local Authorities and the Clean Air Act

I

by

Alderman G. H. Goulden, J.P.

From the Society's standpoint the Clean Air Act is an epoch-making event. It marks the first fruitful yield in its fight for pure air but the time is not yet for complacent satisfaction at having breached the bastion of apathetic lethargy. The fruits are yet to be garnered and brought to maturity ere the next phase is approached.

What has emerged may not be palatable to a number of old campaigners but it is a distinct progressive approach towards solution of a huge problem, rendered more complex by the extensive politically economic changes to which we have been subjected and not yet become accustomed. It would be so much easier for a younger nation to achieve the ultimate goal of a smoke free atmosphere.

The problem of smoky air is centuries old, yet only during the last two or three decades have its evil consequences been recognized and the preventive " know-how " developed. Large masses of the population are

ignorant of the possibilities, accepting dirty air as an evil necessity from which the only escape is remote existence. Some are not even smoke conscious. Those who are and do something about their own contribution are few indeed, but only a very small minority are oblivious to the need for a cleaner atmosphere. They look for a determined lead out of their gloom and where do they look for that leadership but stable authority. They will not follow blindly but will be responsive to example rather than precept. Legislation too far in advance of public opinion is most often doomed to failure and ingrained habits cannot be changed overnight.

For long enough we have bewailed the inadequacy of anti-smoke law, the lack of suitable weapons wherewith to attack the monster. Let us be critical, but not unduly so, of the shortcomings of this newly forged one. Rather let us apply the remedies offered in an endeavour to enter the next phase of the campaign sooner than is anticipated for there are other and perhaps more deadly impurities in the atmosphere than just smoke.

The Act is therefore a challenge. The challenge is to the whole smoke abatement movement to show it has not been talking moonshine all these years. Its administration will entail a vast amount of work, by far the greater proportion falling upon local authorities. They will first need to ask themselves if they are suitably equipped for the task of administering the Act energetically. I do not wish to convey the impression of advocating punitive persecution, yet their policy, and theirs alone, will be the driving force. All those organizations and individuals who comprise the movement have a part to play in schooling the public mind to the ideal of a clean air supply, but all will be in vain if local authorities display no more than a benignly benedictory attitude to the efforts of others. The challenge must be zealously accepted by them.

Not all of the hundreds of " black area " authorities will find it necessary to employ full-time technical staff but some provision will have to be made to deal with technical matters arising from administration of the Act. Some may find their needs satisfied by combining with neighbouring authorities in utilizing a service of that kind. If advantage is to be taken of the opportunity afforded by Sec. 25, theirs will be the responsibility for initiating and pursuing the cultivation of a receptive background for the advent of smokelessness. Already it is partly conditioned but the process has to be maintained to achieve success.

Publicity and Propaganda

The value of well-directed publicity and propaganda cannot be overstressed. The vested interests in the movement are anxious for opportunities to assist in that sphere. It is for local authorities to provide those opportunities. Information about local conditions is far more impressive than vague references to soot-fall in some distant place. To be thorough in this matter more measurement gauges are needed. To record the improvement, using it to spur on the effort, one to every square mile is the least requirement. That is the only evidence of success acceptable by the public at large. Complacent indigence is engendered by resignedly congratulating oneself that one's town is not as dirty as another, a circumstance which may be attributable to God's grace alone. The improvement effected in St. Louis and Pittsburgh is often quoted. How much better when we can quote Bristol or Halifax. Individually and collectively we are judged by the example we set. Let all local authority buildings be made smokeless and our houses too. New estates are equipped for burning smokeless fuels and the tenancy condition method is the readiest means of making large areas smokeless. One's Council colleagues? Are they behind the movement? What about getting their support? The Act is an all

party measure

Powers under the Act

Up to this point I have only dealt with conditioning ourselves to the new attack upon smoke and now turn to things in the Act which are more specific.

Dark smoke emission beyond certain limits (at present unknown) becomes an indictable offence. This complete departure from nuisance procedure exemplifies a determination to eradicate smoke from the industry, though witholding of the "unsuitable fuel" defence in the case of black smoke would have strengthened that view. The experts tell us that this defence is unwarrantable, that fuel quality is no bar to compliance with the new standard, that equipment is available to burn the most unfavourable fuels efficiently with little smoke. They may be right but are the supplies of those fuels for which a plant is designed always available? This is a matter which the Ministry of Fuel and Power and the National Coal Board will have to regard with serious concern. No longer will it suffice to over-allocate the most desirable coal, which everyone wants when trouble looms, and then shunt it around to pacify objectors. I suppose disparities are inevitable in the matter of fuel quality, but industrialists have the right to feel that having provided equipment to burn the coal allocated within reasonable limits that particular quality or grade will always be received. Failure to devise a system which will prevent wide deviation will impede local authorities in their efforts to bring furnace equipment into shape during the seven years period of grace available under the Act.

The system of exemption by annual certification during that interim period permits some sort of programming by local authorities, manufacturers, the Ministry of Fuel and Power and the National Coal Board. It demands alert watchfulness by local authorities lest they find themselves the victims of unscrupulous concerns deliberately contriving to defer plant modernization to the last year of the seven. They must be prepared to demand from applicants for temporary exemption the greatest endeavour to put into effect in the shortest possible time whatever needs doing. Delivery dates for new equipment will obviously lengthen with increased demand and it will not do to be too charitably accommodating in the matter of licensing. Definite undertakings ought to be required before an application is considered.

Section 3 virtually imposes on local authorities the duty of operating a scheme for the prior approval of new furnaces with this difference. Notice of intention to install becomes obligatory whereas under pre-act schemes installations were often under construction before knowledge filtered through to the local authority. Experience in Salford shows this method of preventing new sources of unnecessary smoke is extremely valuable. Quite a few schemes have been rejected on the grounds that the furnaces would operate satisfactorily on coke, which they now do. In others it provided opportunity to guard against grit and ash emission where the item had been overlooked. Why approval is not also required for major alterations and additions is a mystery and we shall have to see whether or not eminently desirable instrumentation can be insisted upon. This section once more points to the need for local authorities to have technical advice available and it occurs to me that the National Fuel Efficiency Service may be prepared to assist in that capacity.

Here and there in the Act, administration is dependent upon regulations to be made by the Minister and it is hoped these will not be long delayed or we might find ourselves with a contrivance whose vital parts are missing. One concerns the installation of smoke density meters. Automation is a subject much heard of lately and here is a circumstance where the time and drudgery of chimney watching might be reduced. For instance, smoke density recorders operating throughout

the day and night might be made compulsory after conviction for dark smoke. There would then be a constant check on the very chimneys likely to offend. A point to consider is whether their cost should be borne by the local authority or the user of the chimney, but as their use permits the operation of a bonus system for firemen, probably the firms are the right people.

I only refer to Sec.10 (heights of chimneys) to say that in view of the large quantities of ash thrown out from pulverized fuel burning, even where efficient arresting systems are operated, it is regretted that new electricity stations are exempt. In the application of this section there will need to be close liaison between the Health and Building Committees.

Domestic Smoke

Perhaps one of the most difficult situations and most controversial subjects is domestic smoke. There is no need for me to reiterate the authority in the Act for dealing with it.

Smoke Control Area development is obviously geared to solid smokeless fuel availability and as this largely means coke the gas industry must look to its laurels for it is not just more coke that is needed, but better coke at a price which will commend the fuel to everyone. The Gas Council has given considerable thought to the problem of increasing supplies of coke suitable for the open grate and as expected is not finding it an easy one to solve. Apparently there is no incentive to produce coke at a price less than that of middle quality coal, but could not a free-burning super-coke be marketed under a trade name. In return for the superior product, domestic consumers, I feel sure, would be prepared to pay a reasonable price for it.

Domestic coal consumption in the " black areas " runs to some 19 million tons per annum. A solid smokeless fuel equivalent of 15·20 million tons has been assumed, but in practice that assumption is a very doubtful quantity. However it is obviously quite wrong to suppose that the whole of the " black areas " can become vast control areas within 10-15 years.

The Gas Council visualizes switching $4\frac{1}{2}$ million tons to the domestic market from other users. By changes in methods of gas production a further $2\frac{1}{2}$ million tons can be made available, but only by raising carbonization by 10 million tons can there be any hope of substantially increasing the quantity of coke marketed. By 1959, after making all allowances for transfer, new production, additional use of electricity and oil there will be a deficiency of about 8 million tons. Of course, one influence of smoke control area development will be to increase consumption of gas and therefore coke production, but that is insignificant compared to real needs. The gas industry may have confidence in its ability to extend the market for gas, but bearing in mind the competition from electricity and oil, he must be an optimist who visualizes the industry meeting the solid fuel needs of the " black areas ". There is also the further problem of supplies of coal suitable for gasification. In a matter of conjecture such as this it appears that by various means gas coke suitable for domestic use can be brought to about 14 million tons. Throwing in low temperature carbonized fuel, anthracite etc., some 17 million tons of solid smokeless fuel would become available, leaving only 2 million tons for use outside the " black " areas. That is insufficient. Beaver enjoins that " the use of smokeless fuels outside the black areas should not be discouraged ". It is probably not possible to channel more than nine of 10 million tons to the black areas, which means that, allowing for part of the load being taken up by electricity and gas, two-thirds of the black areas could be included in smoke control areas within 10 to 15 years. This seemingly is the present target.

How the additional tonnage of carbonizable coal is to be made available I do not propose discussing, but when it is remembered that of 130 million tons of such coal now pro-

duced, 77 million tons is burned in the raw state the obstacles should not be insurmountable. Most house coal replaced in black areas is suitable for carbonization and will become available, but much will depend on future national fuel policy.

What, to local authorities, are the financial implications of smoke-control areas?

Their minimum liability in privately owned dwellings is three-tenths of the expenditure reasonably incurred on adaptations and the like, but at their discretion the contribution can be doubled. In municipally owned houses the contribution is three-fifths.

When considering the meaning of the words "expenditure reasonably incurred," doubts occur regarding the extent to which local authorities are justified in contributing. The doubts arise from the fact that we do not at present know how far "works reasonably necessary" takes us. It is what the Minister accepts as "reasonably necessary" that matters. It requires earnest consideration before any local authority commits itself, which it must do before submitting an Order for confirmation. Failure to do so will breed distrust.

Existing heating accommodation may consist of a coal-fired range and several other firegrates, none capable of burning coke. Replacement of them by coke burning grates and a gas or electric cooker is the solution but new hearths and surrounds will be needed and perhaps a new back boiler which, but for the alteration would not have been necessary. How much of the hearths, surrounds and back boilers qualifies for exchequer grant? Obviously not all of it, otherwise local authorities and the Treasury become more than charitable institutions.

There has been depreciation of existing appliances and something must be allowed for it. The Act suggests three-tenths.

Is it reasonable to convert space heating appliances in any but regularly used living rooms, or should bedrooms, back kitchens and cellars be excluded from the reckoning? This seems reasonable, but some guidance from the Minister is required. We do know that it is not permissible to contribute to a scheme for changing over from open fires to central heating beyond the cost which would have been incurred in replacing the open fires.

Whether a local authority contributes only the compulsory contribution or a higher proportion, is for itself to decide. It appears to me that whatever policy is to be adopted must, in all fairness and in view of the possibility of objections, be decided before an Order is made. Only a feeling of distrust can ensue from not doing so.

One further point on adaptations. Everywhere reference is made to the work being executed by "owner or occupier" presumably because, in fact, most occupiers will carry them out and be happy to do so. There will be cases however where the occupier of a dwelling is unable to afford even the three-tenths. Notice will have to be served requiring the carrying out of adaptations. In my opinion the notice should always be served upon the owner even when he is unknown, thus protecting the local authority's interests should he ever turn up, and at the same time easing the burden for the harassed tenant.

As a matter of interest here is a rough estimate of the cost relating to 700 local authority and 458 privately owned houses, taking no account of the unknown quantity—back boilers.

With seven and a half million houses in the black areas, and development taking the pattern of using new estates as nuclei, as I think it will, the cost of this part of the operation looks like being about £175 million of which some £77 million might fall on local authorities.

To make two-thirds of the black areas smokeless inside 15 years would be a tremendous achievement. Intelligent self-interest dictates that it should be done. With sufficient faith in the project, each local authority, large and small, will apply itself zealously to the task of cleaning its

	Total Cost £	Exchequer Contribution £
*Local Authority dwellings (Post- and Pre-*1945)		
Alterations to " approved " appliances	130	52
Conversion of 918 old type grates and ranges (living rooms only)	9,180	3,672
Provision and installation of 40 gas cookers	880	352
Installation of gas ignition at 700 houses	2,625	1,050
Grant towards 918 surrounds and hearths @ £7	6,426	3,672
	£19,241	£8,798

Average cost per house **£28 10s. 0d.**

Privately owned dwellings	*Total Cost* (£)	*Comp. L.A. Contrib's* (£)	*Opt onal Contrib's* (£)	*Exchequer Contrib's* (£)
Conversion of 1,147 old type grates and ranges (living rooms only) ..	11,470	3,441	3,441	4,588
Provision and installation of 18 gas cookers	400	120	120	160
Installation of gas ignition at 458 houses	1,720	516	516	688
Grant towards 1,147 surrounds and hearths @ £7	8,029	3,441	—	4,588
	£21,619	£7,518	£4,077	£10,024

Average cost per house **£48 0s. 0d.**

own atmosphere and ceasing to foul that of its neighbours. From such a concerted effort the rising generation will clamour for smoke control areas and Britain may again add coal to its long list of exportable products for it will be a long time before we can manage without it.

I have dealt rather lengthily with some matters and ignored others in an attempt to focus the attention of elected local authority delegates on the parts which seem to matter most to them in that capacity, to provide discussion points when they return to their smoky towns, and to inspire an evangelical spirit.

One thing appears to have escaped attention. The decision to appoint a Clean Air Council is made with the object of keeping all and sundry in the van of progress in matters appertaining to smoke abatement and in that respect it is a wise decision. The prospect of a " Big Brother " attitude does not make much appeal, but of course it will not be necessary if everyone plays his part well.

II

by

H. V. Cass, F.S.I.A.

The implementation of the Clean Air Act will fall largely on the shoulders of the Sanitary Inspectors. These additional responsibilities will be undertaken by them according to the enthusiasm and encouragement given to them by their respective local authorities. The new Act, whilst not being all that the smoke abatement enthusiast might have desired, can be considered, taking into account all the issues involved, to be a realistic attempt to implement the recommendations of the Beaver Committee.

The number of occasions on which various governments have appointed committees, particularly on public health matters, and then proceeded to disregard many of their major recommendations, must be a constant source of disappointment to public health, and on this occasion smoke abatement, enthusiasts. A perusal of *Hansard* and the official parliamentary

reports on the various stages of the Bill is well worth while. Tribute must be paid to Mr. Gerald Nabarro and other Members of Parliament who have fought the Clean Air fight, and we must congratulate all those concerned in the number of amendments which have been secured and which have considerably improved and strengthened the Act. In this short paper I hope to set out some practical problems that sanitary inspectors and local authorities will have to tackle in the administration of the new Act.

Dark Smoke

The new Act makes it an offence for Dark Smoke to be emitted, and it will not be necessary for a nuisance to be proved. Dark Smoke is defined as smoke which is as dark, or darker than, Ringelmann chart shade No. 2. Written notice of offence must be given within 48 hours as against the present 24 hours.

Ringelmann Charts and Smoke Observation

The interpretation of dark smoke by Ringelmann charts will not present any difficulties to experienced inspectors. These Charts have been in use by sanitary inspectors for many years. Some criticisms have been expressed about their inconvenience and the variability in interpretation of the varying grades of smoke densities. Experienced sanitary inspectors know that these criticisms of the use of the Ringelmann Charts are not well founded, and this has been borne out by the recognition of Ringelmann Charts in the Act.

Suggestions have been made that some form of instrument might be more convenient and reliable for smoke observation purposes. An instrument that seems to serve this purpose is the "Smoke Scope" manufactured by the Mine Safety Appliances Company, Pittsburgh, U.S.A. costing 50 dollars. It is marketed in this country by the same Company, whose address is Queenslie Industrial Estate, New Edinburgh Road, Glasgow, E.3. My department have recently purchased this instrument but have not had sufficient experience to offer a definite opinion about its efficiency. I should be glad to hear from colleagues who have had experience of this, or similar apparatus.

In connection with the use of Ringelmann Charts, attention is drawn to Section 34 (2) which indicates that it is not legally necessary to use Ringelmann Charts for smoke observation. This implies, in my opinion, a great confidence by Parliament in the experience, ability, and integrity of the sanitary inspector.

Defences

The defences of lighting up from cold, and the unavoidable failure of plant and apparatus, appear to be reasonable. The defence of unsatisfactory fuel is, however, one which some consider might nullify the objects of the Act. It will be necessary for steps to be taken to rebut in evidence all three defences. Inspectors should satisfy themselves immediately after observation of offending emission about the true causes of the trouble. If inefficient operation of plant is found, then it would appear that it would be difficult for any of the defence pleas to be made. The unsatisfactory fuel defence has been consistently pleaded for many years. It is singular that in my district, when attention has been drawn to offending emissions, without exception nuisance has ceased forthwith and improvement has been maintained, although the same alleged unsuitable fuels are still being burned.

The Beaver Committee indicated in their Report[1] that the elimination of industrial smoke is intimately connected with the efficient use of fuel, and that with few, if any, exceptions, no industrial chimney need emit more than a light haze of smoke if the combustion arrangements are adequate and properly operated.

All experienced sanitary inspectors will subscribe to this view. It is well known that unsatisfactory fuels are being burned with economy and

efficiency in many industrial establishments. This is largely due to progressive industrialists installing, operating and maintaining efficient plants. Attention is drawn to the wording of the unsuitable fuel defence clause which reads:—

" that the contravention complained of was *solely due* to the use of unsuitable fuel, that suitable fuel was unobtainable, that the least unsuitable fuel which was available was used and that all practicable steps had been taken to prevent or minimise the emission of dark smoke as the result of the use thereof."

I consider that the words *solely due* are the most important words in the Section, and I believe they support my contention that if there are other causes of avoidable dark smoke, such as inefficient firing and plant operation, it will be difficult for offenders to use the defence outlined in Section 1.

Other Smoke Nuisance

The procedure for dealing with smoke other than dark smoke and smoke from a private dwelling follows the existing procedure, and the best-practicable-means defence has been retained.

Provision is made in certain circumstances for the notice procedure to be dispensed with on complaint by a local authority to a magistrate.

The question of delegation of powers might usefully be considered by local authorities in order to expedite procedure.

Temporary Exemptions and Defences

It is understandable why the temporary exemptions have been included in the Act. It is obviously impossible for plant and appliances manufacturers to cope immediately with the supply of necessary plant and equipment that will be required. Applications for exemption certificates will require careful consideration by local authorities and their officers, but sound reasons should be produced by applicants before such certificates are granted. The responsibility of granting certificates is placed fairly and squarely on the shoulders of local authorities, and there is no appeal against their decision.

It is here that sanitary inspectors will have to give the necessary technical advice to their respective authorities.

If local authorities have to consider granting certificates, some definite undertaking for immediate reduction in smoke nuisance and a detailed indication of works intended, with a time limit, should be obtained from the applicant before a certificate of exemption is granted.

Regulations

Sanitary inspectors will look forward to the new Regulations, and it is to be hoped that there will be no delay in framing them, and that they will be sufficiently comprehensive to strengthen and make the Act more effective. The provision of smoke indicating, and recording apparatus, and the availability of records to the local authority, will be of great assistance to sanitary inspectors, and will save them much observation time. Sanitary inspectors are already acquainted with and accustomed to inspecting similar types of apparatus, and records that are legally required to be provided in other industries. Criticism of the Beaver Committee's recommendations of a four-hour observation period has already been made by colleagues, and sanitary inspectors will be only too glad when Regulations are being made to give the Minister the benefit of their practical experience.

The new regulations, and the requirements of the Act relating to the installation of plant for minimizing the emission of grit and dust, arm local authorities with additional powers. These proposed Regulations will also be looked forward to with interest by sanitary inspectors. The requirements that local authorities can demand information to enable them to discharge their functions in this connection will be of great value and will provide some interesting data of the amount of pollution from these sources.

Prior Approval

The requirements regarding the notification of the installation of new furnaces can be considered to be a real step forward. I believe in practice that this part of the Act will in the future play an increasingly important part in clearing the atmosphere.

The age of boiler plants and furnaces in this country is, in my opinion, a major contributory factor in air pollution.

In my district the majority of the Lancashire and similar type boilers are over 50 years old and industrialists are having to replace aged and obsolete plant or provide alternative sources of power.

In giving consideration to plans and specifications very onerous responsibilities are being shouldered by local authorities and their officers.

It will be desirable to have some Code of Requirements for this purpose.

I would recommend to colleagues a thesis by Norcliffe of Coventry[2] published by the Sanitary Inspectors' Association in which such a Code is outlined.

Smoke Control Areas

Progressive local authorities will want to implement this part of the Act as soon as possible. Local authorities are now saved the time, trouble, and expense of having to obtain local Act powers. It is to be hoped that financial considerations will not deter local authorities in the formation of smoke control areas. It is interesting to record that some twenty local authorities have obtained local Act powers, but only ten of these have put them into operation, and several of these only apply to newly-built areas. As far as local authorities' new housing estates are concerned there should be no major difficulty, provided the supplies of smokeless and other fuels are available. The sufficiency of fuel stores might give some concern but this difficulty should not be insurmountable. Preliminary and detailed survey work will be required in the older built-up areas. These surveys will occupy a great deal of time. Suggestions have been made that these surveys can be made by unqualified personnel or technical assistants. These suggestions have been made, in my opinion, without proper consideration of the future use of the information. It must be remembered that the information may be required as evidence at a subsequent Ministry of Health enquiry when appeals against smoke control areas are lodged. It would be wrong to entrust this work to unqualified personnel. Sanitary inspectors already successfully undertake similar duties in other Public Health fields and are well qualified and technically equipped to provide the necessary detailed and comprehensive information to enable their authorities to decide future policy.

It will be during these surveys that it will be possible to evaluate and assess possible opposition, and opportunity can be taken to educate and mould public opinion. Public opinion should be more receptive when the financial aids are explained to them, and it should be a useful propaganda weapon. The detailed guidance on these financial requirements should be made available as soon as possible. Co-operation and consultation with the gas, electricity, coal, and other fuel interests will be an essential and continuing necessity if smoke control areas are to be established successfully. These bodies are already playing a very important part in the Clean Air campaign. I am of the opinion that much wasteful competition exists between the gas and electricity undertakings, and steps should be taken to eliminate this. The Minister's confirmation will be required for smoke control areas, and it is hoped that the Minister's approval will be more readily conceded than in the past when local authorities applied for byelaws in connection with black smoke.

Adaptation of Fireplaces and Appliances

This part of the Act follows similar procedure with which sanitary

inspectors are already familiar in connection with improvement and conversion grants. They should present no administrative difficulties, provided adequate records, supervision, and certification of works are effective.

Attention is drawn to Sub-section 11 (4) where the Minister may, from time to time, by order exempt any class of fireplace upon such conditions as he may specify if he is satisfied that such fireplace can be used for burning other than authorised fuels without producing smoke or a substantial quantity of smoke.

This latter requirement will permit the installation of the recently developed modern types of appliances that will burn bituminous coals almost smokelessly, or as the Section reads "without producing smoke or any substantial quantity of smoke."

In connection with the installation of new appliances, there is a need for better instruction to householders in the use of new appliances. The work of the Coal Utilization Council and other bodies in this direction is to be commended, but I believe that appliance-fixers could do much more at the time of installation and subsequently.

Colliery Spoilbanks

A very useful paper was given on this subject at the Harrogate Conference in 1949 by Mr. J. Carr, M.INST.F.[3].

I can speak with some practical experience on this matter, there being in my own district, and within a quarter of a mile of my own home, a burning spoilbank. The method that is used here is the continual tipping of the wet coal washery and other waste with intermittent damping by sprinkler equipment as occasion demands. This method is 95 per cent. successful provided controlled-tipping methods are used and constant attention and supervision exercised.

I would commend and compliment the efforts of the Lancashire County Council in the reclamation and beautification of a number of the spoilbanks in the mining areas of Lancashire.

Railway Engines

The abatement of smoke nuisance from railway engines will depend largely upon the rapid expansion of the British Railways programme of electrification and dieselization. Early progress cannot be expected because of economic and other factors. The new powers should be of considerable assistance in areas where there are large engine-sheds, shunting-yards and sidings where nuisance is most prevalent. It should not be too much to expect of British Railways to give priority wherever possible to such places.

Crown Premises

The requirement relating to Crown premises makes it obligatory for the Minister of any offending Department to enquire and take all practical steps to minimize, and to abate smoke nuisance and prevent any recurrence. Here seems to be an opportunity for all government Departments to review their fuel efficiency arrangements and set an example and play their part in the clean air campaign.

Clean Air Council

There is an urgent need for the Clean Air Council to be appointed as soon as possible. Its formation should present an opportunity for the co-ordination of research and pooling of information of such bodies as the Department of Scientific and Industrial Research, British Coal Utilization Research Association, the Solid Smokeless Fuels Federation, the National Coal Board, and Gas Council, and other similar bodies, who appear to be working independently of each other, particularly in research in connection with smokeless fuels. The Minister will no doubt see that representation will be such as to make the Council a really effective body. It should not be too much to expect that the officers administering the Act should be represented, as well as the National Smoke Abatement Society.

Building Byelaws

The Minister should, at an early date, see that suitable model byelaws are framed. These when adopted by local authorities will enable them further to implement a clean air policy. Sanitary inspectors already assist in the adjudication of plans and will be able to obtain, keep, and use such records for the implementation of future smoke-control areas.

Research and Publicity

The comprehensive power given to local authorities to contribute towards the cost of publicity, research, delivery of lectures, holding of exhibitions, and other matters in this connection should be an opportunity for local authorities to co-operate and use the services of the National Smoke Abatement Society and enable it to expand its work.

Conclusions

At the outset of this paper I indicated that the Clean Air Act was not all that smoke abatement enthusiasts might have desired. We should, however, be encouraged by the fact that we are the first country in the world to have national legislation on clean air.

Local authorities have the responsibility of enforcing the Act and they should of necessity see that their own house is in order to avoid repercussions and criticisms.

The successful enforcement of the Clean Air Act, like the majority of public health and similar legislation that sanitary inspectors are called upon to administer, will depend upon sanitary inspectors and local authorities endeavouring to secure the goodwill, education and co-operation of all the interests concerned, rather than by wielding the big stick of prosecution.

Sanitary inspectors can be relied upon to carry out effectively their responsibilities in this connection, and it is to be hoped that these additional responsibilities will be recognised in the appropriate manner by encouragement in all directions by their local authorities.

[1] Committee on Air Pollution—Cmd. 9322.

[2] Smokeless Zones and Prior Approval of Industrial Fuel Burning Installations, 1953—D. C. Norcliffe, F.S.I.A..

[3] The Problem of Burning Colliery Spoilbanks—J. Carr, M.INST.F. (National Smoke Abatement Society, Proceedings of the Harrogate Conference 1949).

III

by

Professor A. B. Semple, V.R.D., M.D., D.P.H.

Introduction

The last decade has seen a resurgence of public opinion and a gradual increasing enthusiasm by legislators, officials and technicians to tackle the growing menace from atmospheric pollution. Unfortunately, there is some public misconception that the present interest is the dawn of a new era for smoke abatement. Yet, the past records of the National Smoke Abatement Society show that similar outbreaks of enthusiasm have been followed by setbacks, frustrations and apathy, and we must ensure that, on this occasion, the effort is maintained.

In slum clearance, environmental hygiene, drainage and water supply, progress, beginning slowly, steadily increased after the first pioneering steps had been taken; but with smoke abatement, progress has been slow and intermittent. The improvement in the overall scene up to the present has been brought about mainly by weak

legislation coupled with years of slogging educational work, the brunt of which has fallen to the lot of the sanitary inspectors in industrial areas.

In 1846, Liverpool included in a local Act power to prevent smoke emission, and in the subsequent 30 years approximately 15,000 prosecutions were taken against offenders, which included some 6,000 in respect of river vessels. The inspectors were constantly reporting the improper construction of furnaces, inadequate boiler space, unsuitable fuel and lack of stoking technique. Fines were imposed on an average of £1 per infringement. Today, the average is £3 to £5, and therefore, as history occasionally repeats itself, will the legislative approach envisaged in the new Act stimulate only a temporary enthusiasm?

Although much has been written in both the technical and lay press on the dangers of smoke, and there is hardly a person in this country who cannot be aware of the effects of fog and other results of atmospheric pollution; how far do these lessons actually penetrate and lead to positive action? First, let us consider the householder, who, we are told, contributes 50 per cent. of the pollution of our atmosphere. Does he practise careful stoking or put modern fuel appliances before his requirements for television and other wonders of this electronic age? Secondly, when managements are considering their annual expenditure, does the boiler house come first or last? Judging by the average structural condition and equipment still being used it would appear that many are not even considered in the long term programme of expenditure. Has the propaganda caused in any way an association with smoke of any real public health menace? The word itself has no frightening implications, still being associated with prosperity, increased trade and progress, or comfortable relaxation, warmth and good cheer. And thirdly, do public bodies such as the nationalized industries, hospital boards, and local authorities give the replacement of obsolete steam raising plant proper consideration in their capital schemes, or do they prefer the promotion of private empires to the fostering of public good?

The Local Authority's Problem

The Act has now placed additional duties upon the local authorities. They have to control industrial smoke, examine plans submitted for new plant, carry out new responsibilities in respect of grit and dust emission, develop smoke control areas, and be ready to absorb any duties that the Minister may add from time to time. I trust that one of these will be some representation of local authorities and health officers on the Clean Air Council. In addition there will be considerable informal action concerned with propaganda and educational work.

Throughout the administration of all these duties it will be necessary for the local administration of the Act to be closely associated with national trends. In our desire for a considerable reduction in atmospheric pollution we must not overlook the economic and political factors involved; nor neglect the slowly dawning appreciation by the public that perhaps the indiscriminate burning of coal is wasteful. The steadily rising cost of coal is now becoming an important factor, and in industry many managements are giving serious consideration to their steam raising plant, although smokeless combustion is only incidental to their desire for fuel efficiency. Although the Act has not followed the legislative pattern of the slum clearance drive by calling for a survey, there is no doubt that a complete assessment of all the problems in the area should be correlated and examined before embarking upon a planned operation.

I have no desire to set the Liverpool operation as a model, but I feel that our experience during the last two years may be of some assistance to those actively engaged in smoke abatement.

The city has been divided into three spheres of operation, (a) the river, (b) industrial areas, and (c) residential areas. This three-pronged attack was decided upon because of the technical problems involved, the deployment of highly skilled staff, and the limited progress that can be made in the residential areas.

Before deciding upon the methods to be adopted all the information concerning the city was card indexed. From these records it has been established that there are some 5,000 factories of which 1,429 industrial plants are recorded where action is being taken to convert to smokeless combustion.

Further, there are 204,486 residential premises of which some 90,000 are still using old-fashioned open grates. Statistics of this type assist in formulating a policy. The policy is dictated after full assessment of the problems which must be planned in a large city for making the best possible use of a small band of highly specialized personnel involving specially qualified sanitary inspectors and mechanical engineers. This section is used mainly as consultants by industrial managements requiring technical advice. They are also responsible for the preparation of evidence with regard to court cases and the serving of statutory notices upon persistent offenders, and also give attention to the problem of smoke from shipping.

With regard to isolated industrial premises and complaints of smoke nuisance from other sources situated in the residential areas, these problems are dealt with by the district sanitary inspector. Thus simultaneous action is being taken all over the city, and there is, of course, considerable informal action in respect of Crown properties, including hospitals, nationalized industries (power stations, gas works) and local authority undertakings.

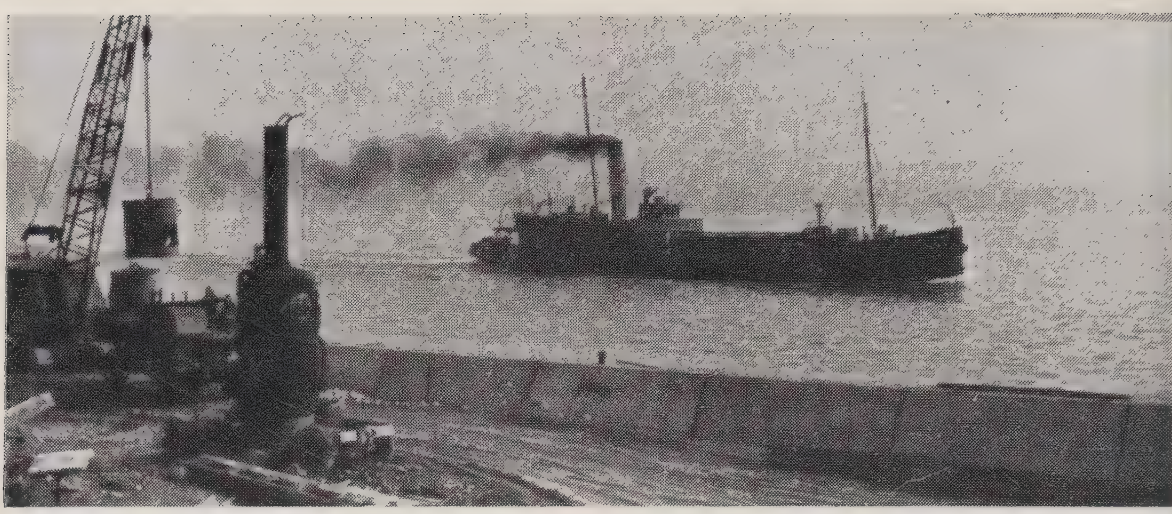
In addition, initial steps have been taken to prepare a smokeless zone.

Care must be exercised in selecting an area and only a comprehensive survey can reveal the most suitable location. Naturally, the area should require the smallest possible number of plant conversions and must avoid including the troublesome black spots involving, perhaps, premises that may be subject to temporary exemption, exempted premises, or scheduled industrial processes. By this method it has been possible, in Liverpool, although the date of authorization is not anticipated until next year, to convert 1,600 of the premises in the area out of a total of 2,000 to some form of satisfactory heat production.

Efforts have been made to get municipal plant into a high state of efficiency in order to give a lead to industry. Already the Baths Committee has accepted a recommendation of the Baths Manager and Engineer to embark upon a scheme of boiler modernization over a period of 10-15 years.

1. Smokeless Zone

Contaminated by power station smoke outside zone



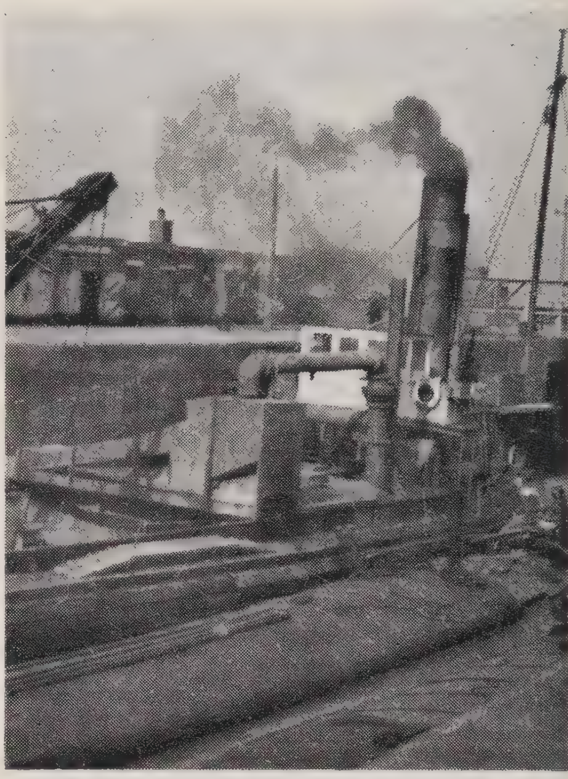
2. The River Problem

In addition to the constant observation and survey there must be considerable statistical information concerning the pollution deposits, suspended matter or toxic gases. In the same way as a doctor recognizes changes in temperature and other symptoms as an indication of a patient's progress, so statistics of this nature, examined weekly and even daily, can serve a useful purpose in recognizing whether the moribund patient of a large city, partially asphyxiated by a dangerous intake of smoke and toxic gases, is slowly recovering, or slowly going further down the road to destruction, stifled by the products of its own waste processes.

Furthermore, we have been operating a scheme of " Prior Approval " in co-operation with our City Building Surveyor and local architects for some 5 years, and more recently under local act powers. We see all plans for new heating plant in the city and get a chance to discuss any unsatisfactory features at a stage when something can be done about them. The Act will make this procedure general, and will be most welcome.

Shipping

The ships using the Mersey include liners, dredgers, lighters, coasters, drifters, and many other auxiliary vessels. The amount of smoke pollution caused by vessels in the Port Area



3. Smoke from Dredger

is a serious problem and the attention of the department is concentrated upon this so far as is practicable under present circumstances.

During 1955 some 1,295 observations of shipping were made and, where possible, offending vessels were visited to inspect the stokeholds. These inspections were followed by advice and instruction as to the best means to reduce the excessive smoke.

In the majority of cases vessels are moving from berth to berth, leaving

port or arriving in the river to enter one of the docks or to proceed via the ship canal to the Port of Manchester.

It is estimated that some 500 or 600 vessels use the docks and river daily, in addition to which there are perhaps some hundred industrial boiler chimneys, Mersey Docks and Harbour Board locomotives, etc., in operation within the Port of Liverpool.

Thus it can readily be understood, the vast problem of excessive smoke emissions from a port the size of Liverpool. From a close investigation of smoke from shipping on the river and in the docks over the past few years, it has been established that the worst offenders are certain dredgers, sand hoppers, and tugs operating on the river, the smoke from these vessels was appallingly heavy and continuous over long periods, but following the successful legal proceedings instituted against the owners of three tugs and a sand hopper, together with the help and advice from the department's technical officers, a considerable improvement has been noted. It is not always possible to inspect conditions on board the vessel at the time of the excessive smoke emissions, but smoke from shipping is caused by:

(a) careless firing (the sea-going practice of carrying thick, heavy fires is widespread);

(b) lack of knowledge as to the type of firing necessary to prevent excessive smoke; and

(c) worn out plant for steam raising.

There are many practical difficulties associated with the normal shipping plying to and fro in the river and unless further regulations are carefully compiled many of these classes will be exempted from action.

Section 20 of the Clean Air Act relates to vessels and applies the normal procedure relative to dark smoke emission from buildings contained in the first two sections of the Act, in other words " vessels " become " buildings ".

Sub-section 3 states:—

" The waters to which this section applies are—

(a) all water not navigable by sea-going ships; and

(b) all waters navigable by sea-going ships which are within the seaward limits of the territorial waters of the United Kingdom and are contained within any port, harbour, river, estuary, haven, dock, canal or other place so long as a person or body of persons is empowered by or under any Act to make charges in respect of vessels entering it or using facilities therein."

In this sub-section " charges means any charges with the exception of light dues, local light dues and any other charges payable in respect of lighthouses, buoys or beacons and of charges in respect of pilotage."

This unfortunate definition raises many complications. In Liverpool the monies payable under an Act of Parliament passed in 1926 allows the Mersey Docks and Harbour Board to charge for the following:—

(1) Local light dues, for light on North-west corner of Gladstone Dock.

(2) Maintenance of buoys and beacons.

(3) Maintenance of channels by dredgers.

(4) Charges in respect of pilotage.

H.M. Customs collect the light dues payable to Trinity House for maintenance of lighthouses and beacons.

However, a general rate is paid to the Board by all vessels entering the river, and this charge is known as the Conservancy Charge or Due, commonly referred to as the Harbour Rate. In addition to paying the Conservancy Rate all vessels entering the dock have to make a further payment in proportion to their tonnage.

There is another charge made to *All Vessels* entering the Mersey, including those docking at Manchester, which is not included in sub-section 3 of Section 20, and that is the charge for maintaining channels. This may bring all vessels within the scope of the Act. Therefore, it will be appreciated before formal action is

taken there are many legal problems to be solved.

The nuisances associated with the volume of smoke from shipping are increasing but the act does not simplify the procedure or authorize legal proceedings in relation to smoke other than dark smoke.

Foreign owned, sea-going vessels periodically using the port may commit an infringement when emitting dark smoke, but the practical difficulties associated with taking formal action within 48 hours in respect of these ships have not been removed as the owner is overseas. When the ship is moving and difficult to board it would be impossible to have the ship stopped merely to lecture the responsible person causing a nuisance or for finding out the cause of the smoke emission.

Therefore there has been no alteration with regard to the procedure which still restricts formal action against either the owner, master, officer or person in charge of the ship, and not on a local agent on land.

It is regretted that action can only be taken in respect of dark smoke and exemption is given for the indiscriminate discharge of smoke, dust and grit. In the normal way this would not cause a problem but due to the smoke cloud rising from the city and port, air navigation is affected.

Dark smoke is defined as dark or darker than Shade 2 on the chart of Professor Ringelmann, but difficulties will be experienced in using this method in respect of vessels on the move, and it would appear that visual observation may provide the only evidence for court proceedings, for which the Act under Section 34, Sub-section 2 now makes provision.

A long experience of smoke emission from vessels on the river has established that one exemption from a set procedure will nullify the efforts to secure complete elimination of smoke nuisances. Where ships are clustered closely together considerable discontent will be caused if the owners are subjected to a procedure which is varied for ships of H.M. Navy and other Government vessels. Therefore all ships at anchor should have been included within the provisions of the Act.

It is appreciated that it would not be possible to include in the Act a section providing for prior approval of equipment and apparatus to be installed in ships, but it is felt that regulations could be made providing for the provision of the small essential devices in stokeholds warning that dark smoke is being emitted.

Summarized Remedial Measures for Shipping

In order to prevent the excessive smoke emissions from ships using the river daily the local authority should have sufficient technical officers to deal with this source of atmospheric pollution.

Recommendations

(1) Maintain constant observation of all ships entering or leaving port, as well as ships berthed in the docks.

(2) Board the offending vessel as soon as possible after the offence in order to advise the ships' officers of the nuisance.

(3) Ascertain the cause of the nuisance and advice the responsible ship's officer of the best action to be taken in order to prevent a recurrence of the nuisance.

(4) Tugs, sand hoppers, dredgers and similar small craft engaged on the river daily should be converted to smokeless combustion either by changing to oil or the adoption of improved fittings, doors, etc.

(5) Advise all shipping companies that in order to assist the stokehold personnel in the economical use of the fuel available, warning devices should be installed.

(6) Legal action to be taken against persistent offenders after warning.

Domestic Smoke

The policy of the local authority under the Clean Air Act for dealing

4. The Domestic Problem

vith domestic smoke is restricted to ark smoke generally or smoke mission in the controlled areas.

The average dwelling-house chimney arely emits dark smoke of the density efined as Shade 2 of the Ringelmann Chart, and progressive action there- ore to reducing the emission of smoke rom domestic chimneys will mainly ccur when they are incorporated in moke control areas. Unfortunately, onfirmation of orders will only be btained when the Minister is satisfied hat smokeless fuel is available in the rea, sufficient appliances are provided uitable for burning the fuel and bjections have been considered.

In the domestic sphere, legal action s restricted and there are some nomalies created, the Act as far as hese premises are concerned is a moke control act and not a clean ir act, for no attempt is made to estrict the use of fuels emitting armful fumes to health, vegetations nd buildings. Furthermore, the Minister may from time to time by order exempt any class of fireplace, if he is satisfied that such fireplaces can be used for burning fuel other than authorised fuel without producing undue smoke.

In the large cities it may be many years before the central areas have been sufficiently smoke controlled to allow the local authorities to devote their efforts to the problems associated with adaptation of appliances in houses in the older residential areas.

The problem in the domestic sphere may be divided generally into the old and the new. In the new residential areas close co-operation with the architects, and, of course, residents, may resolve the problems. In the older residential areas many of the houses are sub-standard, and the tenants, due to housing dilapidation and lack of maintenance, may have already lost house-pride, therefore, is it possible that their attention could be focused on one particular aspect,

namely, the open fire, when the house fabric itself is deteriorating, the roof leaking, the drains defective, and they are without a bathroom or hot water system?

Furthermore, the recent experience of local authorities from a financial point of view in administering the patching clauses of the Housing Repairs and Rents Act, 1954, will not cause an enthusiastic response to spending vast sums of money merely to convert or adopt heating appliances.

Section 13 of the Act provides for the Minister, out of monies provided by Parliament, to make a contribution towards the expense incurred by the local authority. The contribution is a single payment equal to 4/7ths in certain expenses, and 2/5ths in other expenses. Therefore the local authority will still have to find large sums of money as their share in enforcement.

Formal action taken to solve the domestic problem would appear to be fraught with a certain amount of financial complication and difficulty, more rapid progress may be made by informal action involving propaganda and persuasion of occupiers or owners to convert their appliances in which the trained officers of the local authority are expert.

The Beaver report has not overlooked the difficulties in smoke controlled areas, and advocates with regard to new housing estates conditions of tenancy regarding the use of smokeless fuels.

The questions relative to the insertion of suitable appliances, suitably designed dwellings and correct insulation to maintain a basic high efficiency must depend upon co-operation with architects, owners and occupiers, although the specialist officer on smoke abatement can administer the appropriate prod at the right time and in the right place.

To solve the problem of domestic smoke may mean discontinuing the use of 36 million tons of coal a year. This situation, mentioned in the Beaver report, recommends that attention should be concentrated on the black areas only, where pollution was invidious, and therefore the problem would be replacement of 19 million tons.

To replace one ton of coal by smokeless fuel, burned in approved appliances, would require 16 cwts., logically 15·2 million tons of smokeless fuel is needed to replace the high volatile fuel now being used. There is unfortunately, however, only a limited amount of smokeless solid fuel immediately available, but there is an encouraging trend to greater use of electricity, gas and oil, including paraffin.

It is extremely problematical whether manufactured fuels such as Phurnacite and low temperature cokes, (Coalite and Rexco) could fulfil the demands, and further increased conversion needs may have to be met by greater utilisation of gas coke.

Unfortunately there is considerable resistance to the use of coke. There are traditional objections and mistaken notions that coke gives rise to fumes; also flying splinters produced by impurities in the coke which can be dangerous.

A survey carried out by the Coal Utilization Council revealed that the proportion of houses fitted with modern appliances for fuel smokelessness is only about 18 per cent. Few of the individual householders are conversant with the free standing grates or the convector fire or other modern improvements.

Education must be carried out by officers armed with facts and arguments that will arouse the interest of the occupiers and owners. Facts similar to those used in environmental hygiene propaganda concerning plagues and epidemics are useful. It may be possible to compare polluted air with polluted water and attendant risks of ill-health. For although many householders still regard with good humoured tolerance our effort to abate smoke, they are extremely concerned with aspects that may affect the health of the family.

From these arguments you will gather that there can only be one group of officers capable of under-

5. Transport Problems

taking this formidable task, namely, the Medical Officer of Health and his team of fuel technologists.

Summarizing the domestic problem, the local authority must devote more time and money to educational propaganda, and its officers must shoulder the burden of addressing, advising, or lecturing individuals or communities of people wherever they gather to discuss this subject.

Railways

The Beaver Report states that railway locomotives are responsible for over 1/7th of all the smoke discharged into the atmosphere, and in common with other large authorities, or black areas, we are all convinced that the major part is in our particular district.

In Liverpool there is a very large marshalling yard at Edge Hill, which during the war years, attracted the attention of the Luftwaffe and now is the focal point of the belligerent attention of inhabitants in the locality.

There is also a considerable smoke nuisance in the vicinity of two large railway stations. The depressing effect of a large station set in the vicinity of a smokeless zone can well be imagined by all actively engaged in the war on smoke. The only complete answer is the replacing of the coal-fired locomotive by electric, diesel or other smokeless methods of traction, but the British Transport Commission's plans include only a limited number of schemes for electrification and a long-term programme with regard to the replacing of coal fired engines by diesels or gas turbines.

A palliative to the problem associated with the major marshalling yards and railway stations is the introduction of the diesel shunting locomotives, but although there were in 1954 already 250 in service, there will only be 800 in use by the end of 1957, which is 30 per cent., of the total shunting locomotives in use.

Section 19 of the Act applies to railway locomotives as it does in relation to buildings, but only to dark smoke and exempts smoke, grit or dust.

The problem does not concern itself with the sporadic burst of dark smoke from a railway locomotive, but the volume of smoke, dust and grit mixed with steam arising in vast quantities from marshalling yards or large railway stations. Legislation cannot solve this problem and only modernization or the adoption of palliatives can hope to assist the local authorities.

Electrification may be too ambitious at this stage, and the British Transport Commission consider that the benefit from the use of atomic power is likely to be indirectly obtained through the development of nuclear energy at electric power stations.

Diesel traction offers many advantages and the changeover does not involve large scale engineering conversions whether associated with

6. Crown Property

the railways, signalling works, or civil engineering.

The long-term plan of the Commission of combining electricity, diesel traction and including gas turbine propulsion is encouraging although the cost of £1,200 million to be spent in the next 15 years may suffer some curtailment with the present economic credit squeeze. It is said that 1956 may see the end of the production of new steam engines and the age of the steam locomotive is limited.

Therefore, the local authorities, as an alternative to limited legal action, may still have the depressing duty of constant observations, placating irate householders, and seeking the co-operation of the Railway Staff until the long-term plans come to fruition.

Special Cases

The first important point from the local authority's view is that there has to be special cases with different administrative procedure. This causes complication in administration and acts as an irritant, and in many cases arouses the owner or occupier of penalized premises to criticise the local authority because they quickly form the opinion that certain establishments are being protected. The hospitals in a large city are perhaps the biggest offenders, and although action may be taken at ministerial level, often the response is only in the form of a reassurance that everything possible is being done.

The Beaver Report recommends that scheduled processes should be the subject of supervision by a Central Technical Inspectorate and not by staffs of local authorities. Neverthe-

7. Liverpool's Special Problem

less, the Government in its wisdom decided that the Minister may by order transfer to the authority the duty of enforcing the provisions of the Act within its district.

Many of the larger authorities with specially qualified personnel will consider making a request for the transfer of these duties, for the local officers are more aware of the discomfort and psychological effects to the inhabitants adjacent to many of these highly technical processes, and inculcated with a sense of urgency to secure the abatement of smoke nuisances.

A recurring source of complaint in Liverpool is an irritating smell affecting a large area of the city from a nearby oil refining plant which deals with 5 million tons of oil per annum, and although sums between £60,000 and £100,000 are being spent annually in mitigating this nuisance, and the total cost may reach a quarter of a million pounds, this type of plant requires the constant attention of the local authorities and the close co-operation of the Alkali Works Inspectorate. Co-ordinated and concerted action by the local authorities affected has reduced considerably in the last few months the nuisance from this particular establishment.

Therefore I am confident it would be a mistake for the specialist local officers concerned to leave these isolated pockets within their area and throw the full responsibility on to the Alkali Works Inspectorate. This type of formidable problem is not confined only to industries of this character, there is the same vexatious problem from power stations, one may create so much nuisance as to cause widespread interference with visibility over a large area.

A great deal of thought and money have been expended in the prevention of pollution, but power stations must always remain a potential danger by creating dust because of the great quantity of coal used.

Liverpool's special problem concerns a power station which uses 2,580 tons of coal per day, contaminating the smokeless zone with a large emission of gas. There is no known plant capable of preventing completely an emission of dust, although a proportion of this plant has been converted to pulverized fuel with electrostatic precipitation. The other sections rely entirely upon slack with mechanical arrestors.

During the last 15 years dust and ash contents of coal have so increased that many of the arrestors are overloaded. This particular problem is the cause of a smoke plume which hovers over the city, and has a persistence of nearly 30 miles, interfering with air navigation and accentuating the smog problem.

Again complete co-operation between the local authorities and the Central Electricity Board is necessary and several meetings have been arranged, including consultations with the Chief Engineer of the Ministry of Fuel and Power. It is possible that out-moded power stations may come within the temporary exemption provisions outlined under Section 2 of the Act by reason of the nature of the building or its equipment.

The inequality of the load and absence of adequate large scale methods of storing electrical energy reduces considerably the efficiency of power stations. Encouraging consumers to increase the night load at off-peak charges for thermal storage in (1) water-heating, (2) floor warming, and more general use of hydraulic power may assist in solving the overall problem of power stations.

The Central Electricity Authority's steam power stations have greatly improved their thermal efficiency, but the current average efficiency is still only 23·85 per cent. The authority, according to the Seventh Annual Report, made a further surplus of £8¼ million and it is hoped that some of this money will be earmarked for complete modernization of power stations causing persistent smoke nuisances.

The solutions of these technical processes will not come unless the local authority, through their officers, maintain constant pressure upon all

8. The Industrial Problem

involved, whether at local or national levels.

Industrial Smoke

The most important requirement in dealing with industrial smoke is an accurate record of all industrial establishments in the area, together with the types of plants used for combustion purposes.

Industrial smoke is dealt with under Section 1 to 10 of the Clean Air Act and provision is made for the prevention of dark smoke, temporary exemptions, prior approval, minimising grit and dust from furnaces, density meters, installations of grit arrestors, records of measurement of grit and dust, and height of chimneys.

There are further powers with regard to the emission of smoke, other than dark smoke, under Section 16 of the Clean Air Act. With regard to prevention of industrial smoke, legal action is of great assistance to the local authority. The service of statutory notices when an infringement has been committed often causes immediate action and prosecution of persistent offenders, and this, together with the resultant publicity, has brought about a marked progress in this city.

However, these militant tactics will not secure an overall improvement unless suitable time is given to the education of management, engineers and boiler house staff. Replacement of worn out plants and outmoded methods of stoking is essential.

Conclusion

The Clean Air Act is the culmination of years of agitation, education and propaganda by devotees of smokeless air.

The Society has been in the vanguard fighting on many occasions a lone battle, and now this Act, although it does not mark the completion of our efforts, is certainly in the nature of a major triumph.

The difficulties of administration may cause a certain amount of despondency that clean air is far from an accomplished fact, but an unbiased assessment of our progress to date must be encouraging. For example, in 1952, 98 per cent. of householders in this country depended upon burning solid fuel in many unsuitable appliances for their means of space heating. Since the publication of the Egerton and Symon Reports development of suitable appliances has been outstanding. In 1947 the approved list contained 26 appliances but in January 1956 there were 575 included.

This is only one aspect. In addition the industrial improvements must be considered; the great strides in the utilization of oil, the increasing appreciation by managements of fuel efficiency; the economic factors of mechanization when compared to inadequate and obsolete hand-fired boilers; all these factors must be placed on the credit side.

Let us hope that this new Clean Air Act will in itself serve as a flame, which will overcome the dampened embers of public apathy and ensure that we have smokeless air for the next and succeeding generations.

Discussion

H. Moore (Hon. Secretary, N.W. Div., N.S.A.S.) in opening the discussion, welcomed the Clean Air Act as a progressive step, but warned that apathy and ignorance were still formidable enemies. He considered that too much emphasis was laid upon securing a favourable public opinion and averred that other reforms had advanced often in the face of hostile public opinion. He felt that the Local Authorities had a heavy burden of responsibility and could be handicapped in their smoke prevention endeavours by the lack of a co-ordinated national fuel policy and insufficient staff of public health inspectors.

He urged that they should pursue a vigorous policy and expose any weaknesses in the new legislation, and called for unremitting efforts to press home the advantage gained to the utmost effect. He complimented the authors on their excellent papers which had provided a sound basis for discussion.

Dame Vera Laughton Mathews, referring to Mr. Cass's opinion that much wasteful competition existed between the gas and electricity undertakings, reminded the meeting that the policy of the Ministry of Fuel and Power was that there should be freedom of choice for the customer; so long as competition was Government policy, it must be the business of an industry to make itself pay. As far as the gas industry was concerned, its only monopoly was for making gas and, for all its services, it was in competition with other fuels.

With regard to the shortage of sanitary inspectors, Dame Vera asked whether this was not work eminently suited to women; she thought the number of women inspectors might well be increased.

E. J. Winfield (Chairman, West Riding of Yorkshire Regional Smoke Abatement Committee) said that, on behalf of his Committee, he placed before Conference the problem of all local authorities in mining areas, namely, concessionary fuel.

It was a long established custom for mineworkers to receive coal at nominal prices. No-one wished to take away that concession, but if, as at present, it must take the form of bituminous coal only, then there was little hope of creating smoke control areas in mining districts.

His Committee felt that it was not impossible to secure alternatives to the present system. Coal as coal could be replaced by credit notes for coke, gas or electricity.

They appreciated that the problem would not be easily resolved, but were approaching both the Yorkshire Branch of the National Union of Mineworkers and the North Eastern Division of the National Coal Board in an endeavour to inaugurate discussions. They understood that other similar Committees were taking similar action and realized that the solution could only be found at National level.

In conclusion, on behalf of his Committee, Mr. Winfield asked both the Executive Council and the Conference to give all possible help to secure a just and equitable solution to the problem. Unless alteration to the present system was secured the provisions relating to smoke control areas would be denied to mining communities.

County Councillor S. E. Cohen (London) said that, as the Society and many members of that particular audience were well aware, the Corporation of London was a Local Authority which had always been well to the fore in the attack upon the atmospheric smoke problem. The personal efforts of his predecessor, the late Sir George Elliston, a member of the Society for many years and its President from 1945-48, were indicative in some measure of the continuous attention given to smoke abatement in the City of London. More recently, by legislation promoted successfully in Parliament by the Corporation, the City had become the largest Smokeless Zone in the country. For the past twelve months the stipulations and requirements of that Act had been implemented.

He thought, therefore, that it might be of interest to refer briefly to the difference between operation and control under the Corporation's private Smokeless Zone Act, and the operation and control under the new Clean Air Act. Fundamentally, the main difference was that in the City of London it was an offence for smoke of any degree of visibility to be emitted from any premises within its administrative area, whilst under the new Act a seven-year transition period was to be allowed for existing buildings. Domestic premises could not be controlled without the introduction of smoke control areas and in new

premises the Authority was required to investigate details of plant proposed to be installed. The difference would indicate that a Smokeless Zone Act was not only more effective, but required less work in administration to operate.

Viewing the powers possible under the Act, from his own experience of a smokeless zone, County Councillor Cohen said that, whilst the Clean Air Act was a praiseworthy step towards smoke abatement, much work would be required over the next seven-year period to obtain results similar to those gained in a smokeless zone.

So far as the smokeless zone legislation was concerned, there could be no doubt that the effectiveness of any drive to obtain clean air depended upon vastly increased supplies of suitable fuel. Smokeless fuels were in extremely short supply, and that had led many commercial firms to apply to install oil installations as approved installations under the Act. That fuel for heating generation had received encouragement in the City and all applications for oil installations had been approved, subject to conditions controlling the standard of operation and requirement to install smoke protectors.

There was, of course, a clear need to intensify research in regard to means of elimination of sulphur, both at the power stations where oil and coal fuels were burnt in such great quantities, and in the many industrial and commercial plants, where means of control were so much more readily instituted than they could ever possibly be in the individual domestic appliances. He considered that for a local authority such as the City to take steps at that moment to forbid the use of apparatus using oil as a fuel, merely because of the sulphur problem, would be wrong. Nevertheless, he wished there were more adequate supplies of alternative smokeless fuels available.

The Clean Air Act provided some control of smoke emission from apparatus other than in buildings, as the City of London Act had had to include a saving clause in respect of smoke emitted from railway locomotives and, whilst he agreed that the powers then obtained were restricted to what was known as ‘ dark ’ smoke, it was a certain step forward.

Apart from that problem, County Councillor Cohen was glad to report to the Conference that entire success had attended the efforts in the City, and had been attained without even the threat of a single prosecution. Much of the success had been due to pre-publicity and to spade work by the officers concerned.

J. W. Batey (Supt. S.I., Sheffield) said that he wished to draw the attention of Conference to Clause 6 of the Clean Air Act, which dealt in the imperative mood with grit and dust arrestment for furnaces burning 1 ton per hour or more of solid fuel. He stated that the Beaver Committee and the first drafts of the Clean Air Bill had started with a figure of 10 tons per hour and that, in his opinion, had been done with a shrewd knowledge that the figure was too high. It had been brought down to 1 ton, but the figure of 1 ton was still unrealistic. A sample survey of the Sheffield area showed only two furnaces burning at that rate, out of a random sample of some 250 furnaces. To be effective the figure of fuel consumption, at which grit and dust arrestment apparatus must be fitted, should be about 1 cwt. per hour.

A recent comparison of gauge readings, covering the last eight years, in two four-yearly summaries, showed that in the Sheffield area smoke was decreasing (which confirmed the statement made by Mr. Farquharson of Birmingham the previous day), but grit and dust were increasing.

This was only one of many unsatisfactory features of the Bill and was in direct opposition to the view expressed by Mr. Enoch Powell, who had stated that ineffective legislation must be avoided.

Miss D. Boyd said that she was an individual member of the Society, and that she was very interested in Professor Semple’s suggestion that, in the spreading of appreciation of the problem of air pollution, comparison be made between the cost of polluted air and polluted water.

The Beaver Committee, in presenting their Report, had expressed their emphatic belief that the campaign for clean air was as important as the campaign for clean water of 100 years ago. There, their terms of reference had ended, but later, when giving the Chadwick Lecture, Sir Hugh Beaver had given some very revealing figures, and Miss Boyd said she felt it was an aspect of the subject which deserved wide public appreciation.

Prior to the passing of the Public Health Act 1875, deaths from waterborne diseases had been pretty constant at 395 per million of the population per annum. With modern sanitary progress, deaths from water-borne diseases had been

virtually wiped out. Five persons, in over fifty million, had died from typhoid in 1953.

On the other hand, deaths from bronchial and cardiovascular diseases amounted to 425 per million of the population per annum, nearly forty times as many as in Denmark where only smokeless fuels were used.

Moreover, continued Miss Boyd, those figures were in respect of deaths only. The impact of the water-borne diseases was short and sharp—severe illness followed by recovery or death. With bronchial diseases there was an infinite range of disorders and suffering. The British were a nation of catarrhal subjects, and there were very few of them who did not cough their heads off at times.

On the financial side, no figures were at present published by the Ministry of Housing and Local Government on water supplies, but recently there had been such an essential demand for statistical data relating to water supplies that the Central Advisory Water Committee, which had been reconstituted to advise the Ministry, was at present engaged in obtaining information on the cost of water supplies—the amount of capital already involved and to be expended. It was expected that their report would be completed early next year.

Looking around for a few figures to go on, Miss Boyd said it was found that the Metropolitan Water Board charged 9¾ per cent. of rateable value for water supply, and that the average cost of sewage disposal to municipal authorities was 6 per cent. of rateable value. Rateable value in England and Wales was over £366 million at 31st December, 1955, and, if one could assume an average charge for clean water of 15 per cent. that would give an annual charge of £54 million or, for the sake of the present argument, say, £50 million. That was a constant charge, and exclusive of the £1,385 million known to be invested in water undertakings up to 1953, and further large amounts had been earmarked since then.

The Beaver Committee had estimated the direct cost to the country of polluted air at £250 million per annum. During the debate on the second reading of the Clean Air Bill, the capital cost of implementing the findings of the Beaver Committee in full had been estimated at £50 million per annum over the following ten to fifteen years, a gross outlay of £750 million, taking the highest estimate, and the result would be a reduction in pollution in all heavily polluted areas of about 80 per cent.

So, it would appear that, on completion of the investment, the return to the national economy would be about 25 per cent. or the capital outlay recovered in four years; furthermore, it would continue to pay handsome dividends in improved health and higher fuel efficiency, which was ever increasingly vital to their economy.

Miss Boyd concluded by saying that she had brought that comparison to the notice of the Conference because she thought it indicated that, when the full story of the cost of their magnificent water supplies was told, it would make the claims of Clean Air look quite modest, and would be a strong reinforcement to the arguments of those who ardently believed that they could and must afford Clean Air.

J. F. Anderson (C.P.H.I., Edinburgh) said, in answer to the question put by Dame Vera Laughton Mathews as to whether there was no place in the field of smoke abatement for women, that it might interest the Conference to know that in Edinburgh there was an establishment for ten lady sanitary inspectors. Normally the duties of the lady inspectors were mainly connected with house-to-house visitation in Corporation housing estates, but during the war emergency their services had been called upon in the undertaking of sanitary work of a more general nature, in view of the depletion of male staff, and they had performed their duties in a very efficient manner. Mr. Anderson felt that their services could be similarly utilized in view of the shortage of male inspectors at the present time, by their undertaking some of the less technical duties and thereby relieving the male inspectorate to devote more time to the administration of the Clean Air Act.

Councillor Mrs. L. Bartlett (St. Pancras), speaking as a delegate from the Metropolitan Borough of St. Pancras, London, and as a resident of the borough, and a member of both the Borough Council's Public Health and Air Pollution Committees, said that she had had considerable opportunity to appreciate the dangers of atmospheric pollution and to understand the difficulties that face local authorities and such organizations as the Society in their efforts to achieve some improvement in the quality of the air they breathed.

In St. Pancras they had tried for some years, and had met with some success, to reduce the emission of smoke into the

atmosphere. It was very much a "built-up area." It contained factories, houses, hotels and restaurants, three main line railway termini, and three large railway motive power depots, in which locomotives were prepared and steam raised prior to their being placed into service for journeys from the stations. The borough had railway lines running through it almost from north to south, and pollution of the atmosphere by railway engines was one of their major troubles.

During the last few years the Council had made considerable effort to abate the smoke nuisance in the borough and, largely by means of persuasion and incessant observation, many of their factory chimneys had ceased to be grave offenders because the greater number of the industrial furnaces were at present consuming smokeless fuel. Domestic fireplaces, of course, were continuing to add their quota of pollution to the air, but they hoped shortly, with the coming of the "appointed day," and the introduction of smoke control areas, to make considerable progress in a comparatively short time.

Councillor Mrs. Bartlett pointed out that her Council had not been reluctant to seek improvement regarding the emission of smoke from railway engines. They had tried, both by persuasion and legal process, to obtain mitigation of the nuisance caused at the railway depots. In the last twelve months, six summonses had been taken out against the British Transport Commission in connection with railway locomotives. The results were: 20th October, 1955—Four summonses—three dismissed—one discharged—the defendants had pleaded "guilty" in the latter case. 10th August, 1956—One summons—£5 fine—£15 15s. costs. 18th September, 1956—Discharged—the defendant had pleaded "guilty"—£5 5s. costs.

In February 1956 a delegation from the Council had been received by the Minister of Transport.

Although they claimed some achievement, she felt that there was a lot still to be done. She thought that some part of their little success was attributable to the fact that in the Borough of St. Pancras there was, to quite a degree, an interested, strong public consciousness of the necessity for clean air and, like many more people, she believed that if public opinion was strong enough, it would win in the end. To form a strong national public opinion, however, public interest would first have to be intensified, and she suggested that a National Clean Air Week, preferably in December of every year, sponsored by the Society, who she considered were the best people to do it, would probably lead to worthwhile results.

They all remembered the outcry in December 1952, when London was so badly affected by smog that there were 4,000 deaths attributed to it. It was suggested that the "Clean Air Week" be held in the month of December because it was from that month onwards that atmospheric pollution combined with fog had the most serious effect on health.

Councillor Mrs. Bartlett concluded by thanking the Conference for their attention, and formally proposed that during December of each year there should be a National Clean Air Week.

A. E. Snodgrass (C.P.H.I., Bury) asked Professor Semple the qualifications and remuneration of the combustion consultants employed in the Liverpool Health Department, and their relationship to the public health inspectorate. He also inquired whether the use of aeroplanes for smoke observation in Liverpool had proved more advantageous than the traditional procedure of observing smoke emissions from ground level. He gave details of post-advanced courses in air pollution for public health inspectors being organized in various areas by the Sanitary Inspectors' Association, in co-operation with technical training institutions, and commented on the increased traffic on a local railway line in his area since conversion to diesel trains.

F. Taylor said that the point he was raising had already been referred to by the author of one of the papers, and by two contributors to the discussion. Therefore, he did not wish to labour it unduly.

The Clean Air Act appeared to be hailed, in itself, as an automatic solution to smoke problems. The old legislation was acknowledged to be out-dated, outmoded, and inadequate, yet much more could have been accomplished had there been sufficient staff. It had failed principally because there was not.

The Beaver Committee Report had expressed much concern that "only 1·3 per cent. of the total time of all Public Health Inspectors—full-time Smoke Inspectors included—is spent on smoke abatement duties" and went on, "It is clearly an inadequate foundation for the task which lies ahead. The equivalent of a full-time force of 60 men, one to each half-

million population, or one to every 3 million tons of coal burned, could not hope to rid the ' black areas ' of smoke in 15 years. Many more qualified inspectors will be needed," the Report said.

A Smoke Inspector's duties were onerous, continued Mr. Taylor. They started as the first mill operatives were arriving and did not always end with sundown. Sunday morning provided an opportunity to examine more closely the condition of a plant shut for the week-end, and, if he was to relax on holiday, the Smoke Inspector must take care he would be out of sight of a recalcitrant industrial chimney which might disturb his equanimity.

No-one would be attracted to the job until salaries more compatible with the qualifications, duties and responsibilities were offered. If that was not done soon, the Clean Air Act would be another dismal failure and yet another door opened to transference of administration to the Central Authority, for that new weapon could not be allowed to rust and decay, with so many lives in jeopardy.

Mr. Taylor concluded by saying that the hope of reward sweetened labour, and local authorities should demonstrate their earnest intentions by no longer keeping smoke inspectors just hoping. There was no impediment in the National Salary Grades Agreement.

Mr. H. V. Cass, in reply to the discussion, agreed with Mr. Moore and other speakers that apathy and ignorance were the principal factors hindering the clean air campaign. The suggestion of Councillor Mrs. L. Bartlett for a National Clean Air Week was an idea that might be considered by the Executive Council of the Society.

Mr. J. F. Anderson, Chief Public Health Inspector, Edinburgh, had answered Dame Vera Laughton Mathews' point regarding the employment of Women Public Health Inspectors. Mr. Cass believed they would be a useful addition in the domestic smoke field, particularly in the understaffed larger authorities in the black areas.

The whole success of the Clean Air Act would depend upon the initiative of local authorities and their inspectorates, and it was up to local authorities to see that the necessary incentives were forthcoming to attract recruits into the public health inspectorate profession.

Mr. Winfield's point of concessionary coal in mining areas was a very important one. The new appliances that would burn bituminous coals more smokelessly should contribute to a solution of this problem.

Mr. Cass endorsed Mr. Batey's remarks that 1 cwt. per hour was a more realistic figure, and local authorities should start to collect the necessary information to convince the Minister, so that it could be considered when future amendment of the Act was under consideration. He congratulated Miss Boyd on her excellent economic and statistical contribution to the discussion. The information provided by Miss Boyd certainly supported the view that clean air was good business.

Professor Semple in replying to the discussion referred to the many comments respecting the effects of smoke on health. He stated that in the majority of large cities there were approximately 250 tons per square mile of deposited impurities falling and a high percentage of sulphur dioxide polluting the atmosphere. These impurities are only the first stage in the multiple waste involved. The second stage is obstruction of sunlight and daylight and the third stage is the harm done by polluting matter.

There is, in addition, an unseen menace and certainly in Liverpool there is an irritant which could cause cancer. As a result of an investigation into lung cancer large urban authorities may be faced with grave problems of principle involving the interests of different local government services. Liverpool also had a major problem in the incidence of bronchitis and the environmental histories of people both with and without cancer, in rural areas of North Wales compared to Liverpool indicated the relationship between lung cancer and tobacco smoking. The benzpyrene figure in Liverpool is eight to eleven times as great as in the rural authorities.

Professor Semple expressed his pleasure that the coloured slides he had used had revived Dame Vera Laughton Mathews' and others' memories of Liverpool and the North Western Approaches, and stated his appreciation of the many compliments paid regarding the scenes depicted by the slides. He had attempted to cover all aspects with the illustrations and wished to pay tribute to the work of his Chief Public Health Inspector, Mr. Wattleworth, and Senior Public Health Inspector, Mr. Rimmer, for all the work involved in the production.

He replied to the questions of Mr. A. E. Snodgrass, Chief Public Health Inspector of Bury, and agreed that an aeroplane was extremely useful in obtaining views of the

city, particularly in relation to persistent smoke offenders.

In replying to many questions concerning the staff at Liverpool, he stated that the specialist staff included men with engineering qualifications who had also obtained their public health inspector's certificate in addition. These men were used as consultants, but the routine work was now being done by the district public health inspectors to relieve the specialists for experimental and advanced technical aspects.

With regard to the many comments regarding shipping, the problem was extremely formidable and only large scale conversion will solve it completely. Nevertheless, as stated in the paper, there are many improvisations which would help to mitigate this problem.

He then dealt with comments regarding staffing in Liverpool and emphasized that the training scheme was now solving the problem and there was no necessity to consider women public health inspectors. The selected duties that they would be compelled to do would again promulgate the old section system which had been disbanded during the last few years. Staff sections always caused a certain percentage of men to be condemned to work of an extremely routine and boring character and these men became dissatisfied resulting in constant exodus from the large cities.

He concluded by thanking the delegates for their attentiveness during his talk, illustrated with the slides, and the apparent interest and enjoyment which they had so generously indicated at the conclusion of his comments.

Clean Air and the Housewife

SMOKELESS FUEL IN THE HOME

by

Mrs. Mary Courtney, J.P.

On July 4th, 1956 the Clean Air Bill received the Royal Assent and became the Clean Air Act. In this Act we find, under Section 11, the words " Smoke Control Areas. Any local authority may, by order confirmed by the Minister, declare the whole of the district of the local authority or any part thereof to be a smoke control area." The conditions are listed, the help which may be given to householders is stated, as are also the penalties which may be imposed for contravention of the order.

The woman in the house who takes a wise and forward looking view is very interested in this whole question of clean air. It affects her vitally. She has been told that in many towns smoke deposits 300 tons of soot per square mile each year, that the damage caused by air pollution is estimated at more than £250,000,000 per annum, and that emissions of dark smoke threaten and shorten life.

She is, moreover, fully aware from her own experience of the great disadvantages of living in a smoke-laden atmosphere. Just the other day I had a letter from one who lives in such an atmosphere—incidentally, I don't! The writer said, " One gets so tired of this pall which hangs over everything." And, living as I do in clean air, and enjoying it, I was very sympathetic with her attitude of mind, which no doubt is reflected in many ways in her life—not only in the letter she was writing to me. I could understand it so well, having recently flown from London to Renfrew Airport—through bright weather north of London, very quickly giving place to dirty black mist, again into bright sunshine over the Border then into the smoke pall hanging over Glasgow and its surroundings, and on to Renfrew, all within a space of less than two hours.

How tired one must get of this pall which blots out so much beauty, enters into the home, and makes the living of life so much more full of drudgery, unnecessary dirt to be tackled (and it is dirt!), wear and tear on household goods, and over all a general sense of frustration.

There are many " Guilty Chimneys " adding their quota of dreariness, dirt, damage and danger. Maybe they are chiefly industrial and beyond the control of the housewife, but the domestic chimney adds to the sum total, and cannot be ignored. Nor does the housewife wish to evade her responsibility. But, recognizing the contribution she herself should make towards cleaner air, she feels she must know:—

what has to be done
what can be done
how soon it can be done.

And at this point she may find herself in a smog of conflicting opinions and data.

Modern Stoves

She is told that her old open fires burning coal are part of the general trouble. It would be advisable to replace them with modern stoves

burning special fuel. Now, women are interested in modern stoves and would gladly know more about them. They are keen to have them. But are not men somewhat reluctant to change to new ways? Would they not rather, as a rule, live with the accustomed than experiment with the unknown? I think they would. "It is good enough," they say. "We will change one day!" "Wait until we must," and so on. Then, when they do agree to launch out, they are confused—men and women alike—with the variety of choice, and, worse still, the variety of advice offered. And when the choice has been made, involving expense and temporary discomfort, it is followed only too often by disappointment. The new stove does not fulfil all that was promised. I would ask that real attention be given to the guarantees that go with equipment and to the follow up in service, so that the purchaser may be satisfied and the desired result achieved.

Has the time not come to cut down on the plethora of choice in design and to concentrate on performance and economy? Expenditure of this kind is not like the purchase of a pound of tea or a new hat, but rather a long-term investment in personal comfort and the nation's well-being.

Smokeless Fuels

It has constantly been brought into public thinking over a number of years that it is anti-social to buy anti-smokeless fuel. It is patriotic, we have been told, to buy smokeless fuel. And what happens? Those who follow the advice given, try to get smokeless fuel. It is in very short supply. It is unknown when deliveries will take place. And, final and most cruel blow of all, summer prices do not apply to smokeless fuel. The fuel in shortest supply, so far as the nation's work and wealth is concerned, the fuel that is the basic need of so much industry, the fuel that should be used with restraint and respect because of its value, is the fuel that we *can* buy; the fuel that comes under the ban of the Bill, the fuel which is made available at summer prices, thus inciting the wise home-maker to save where she can. But at what cost—the cost of the very principles we are trying to inculcate!

It may have been unavoidable this year, but can we be assured that such a Gilbertian state of affairs will not recur? For to pass a Bill which carries with it penalties, surely cannot mean that we are, willy-nilly, to become lawbreakers of a sort! Is it really expedient to make lawbreakers under the Clean Air Bill of otherwise law-abiding citizens? And, logically, what effect may that not have on other laws? Or, alternatively, is the spread of smoke-controlled areas to be slowed down awaiting a local sufficiency of smokeless fuel? If so, is it impossible to explain the facts quite simply to the home-maker so that she may not be penalized for being ahead of developments? And is it possible to tell her also what contribution she can make in the meantime to the nation's good and her family's greater comfort?

Price of Fuel

So far as the home-maker is concerned, each pound that she has to spend contains exactly twenty shillings. Depending on where she lives, in many cases the purchasing power of her twenty shillings varies, and this is very marked in regard to fuel. I am quite aware of the arguments that can be produced to defend this anomaly: compensating factors in climate, varying cost of transport and conditions of environment. Surely that is not the way to give equal opportunities to purchase what is, after all, a basic need in every home! The difference in climatic conditions within these islands is not very vast, and, therefore, the amount of fuel used cannot present such a great inequality. Transport being nationalized no one should be penalized for living at a distance from the source of supply. And environmental conditions should be met by other means than through a greater individual supply of fuel, and every

effort made to improve the conditions for which extra fuel alone cannot compensate.

As well as considering our comfort, we should take into account our status of citizenship. By underlining the differences in essential needs, we create a climate of opinion that, instead of making for good citizen-relationship, introduces more than an element of controversy and conflict. It isn't enough to flatter the home-maker when you want her to do something: surely she should be treated as a responsible partner in building a new structure that has been agreed to be beneficial to society.

It may seem a far cry from the benefits of smokeless fuel to the problems of disruption in the home, but the thinking of today would lead us to believe that a sound and happy home is the basis of all good citizenship, and so anything that helps to make a home more homely, more the centre of attraction, and more the place that one loves to come into and goes out of with regret, is surely a matter of importance and concern to us all. The fireplace is often the focal centre of home life—traditionally so in this country—and even in the days of the much discussed wireless and television that centre may become of still greater importance. So, on behalf of the home-makers of Great Britain, I would ask that all present should bring as much pressure as possible to bear in the right quarters to ensure that we may have the comfort of an efficiently warmed and equipped hearth—with no smoke drifting up a guilty chimney.

" OPPORTUNITIES "

by

Miss Judith G. Ledeboer, M.A., F.R.I.B.A., F.I.L.A.

It used to be part of the weary traveller's welcome home to see from a distance the smoke rising from his cottage chimney, and to know his family to be tending the pot on the hearth. Modern progress is fast eliminating both hearth and chimney, though in this country there is still a vigorous desire to retain the hearth and the glow of the open fire. While solid fuel remains to burn, there will also be a chimney, but the smoke is destined to go.

In the domestic sphere, the problem of smoke abatement rests with the open fire. In towns, where public services are readily available, we can take it that the fuels predominantly used for cooking are gas and electricity. In the North, and in mining areas where concessionary coal is available, cooking on solid fuel cookers is still usual, but labour saving trends together with the fact that a great number of women go out to work, means that cooking by gas and electricity has become general throughout the South and is being extended in the North of the country. In country districts heat storage cookers are favoured, and they have many advantages appreciated by those who can pay for them. The open fire combination range placed in the living room has still a great following in the North, since it provides the radiant heat that is an essential need in a damp climate varying from day to day. For purposes of the argument, the combination range can be classed as an open fire.

The alternatives to heating a dwelling from a solid fuel open fire are many. It can be done by electricity, but even Electricity Boards will not deny that this is expensive. Gas heating is

somewhat more expensive than by solid fuel. Both are smokeless, and labour saving—this last factor being of great weight in these days. More important is the greater use of these services for the provision of domestic hot water. The ease and low capital cost by which both are installed contributes greatly to their popularity, particularly where conversions are carried out, and where domestic hot water is provided in local authority flatted dwellings. Central heating is an expensive first capital cost, but is rapidly gaining ground in private enterprise undertakings, while local authorities are, for special reasons, hesitating in its use for flat dwellings. Heating by hot air is a post war venture also gradually gaining ground. These two last alternatives are either by oil, gas or smokeless fuel, and do not constitute a smoke abatement problem. Solid fuel boilers for domestic hot water are generally smokeless. To consider in this paper methods of background heating to bedrooms and other rooms is to take the argument beyond that of smoke abatement into the field of general heating requirements for the home. We need to restrict our interest to the open fire in the living room of nearly every house in this country.

Is it possible to prevent this same open fire from emitting smoke? Where smoke control areas are established the use of bituminous coal will be prohibited. In other areas, its use will be eliminated only if smokeless fuels can make as equally an attractive fire as the coal fire. It is hardly necessary to repeat what has been said again and again that smokeless fuels, whether coke, Phurnacite, Coalite or anthracite must be able to give the same welcoming glow, must be labour saving in use, and must be readily available at a low cost. If the public are kept well informed and if installations are made attractive smokeless fuel will gradually supersede the use of bituminous fuels, in all but low density areas.

The opportunities for substituting bituminous burning fires in more densely developed areas for smokeless fuel fires are particularly favourable at present, and would exist even if smoke control areas were not to be established. We are told that 30 per cent. of the houses in England and Wales are obsolete, and that there are 850,000 unfit houses. The Government have redirected the housing effort to a slum clearance programme, which if vigorously carried out will soon affect the centres of our large towns. Already in London, Birmingham, Liverpool, Manchester, areas which once produced domestic smoke are being cleared, and being replaced by dwellings heated in a variety of ways with smokeless fuel installations.

Where actual clearance does not take place renovation can be an agent for smoke abatement. The great experiment now being undertaken by Birmingham Corporation under the 1946 Compulsory Purchase Order containing nine hundred and eighty one areas consisting of 29,526 dwellings is likely to lead and should be used to convert the inhabitants to the use of smokeless fuels. Furthermore the use of improvement grants under the 1949 Housing Act may lead to a considerable number of conversions to smokeless fuel by owners or by local authorities. The present Government housing policy can be used to assist smoke abatement in every town in the country.

Parallel with this, we now have the prospect, at the framing of the Clean Air Bill, of the establishment by local authorities of smoke control areas. While installation of smokeless fuel burning appliances is no problem in new dwellings, their forced installation in existing dwellings immediately present the individual tenant or owner with the difficulties that are inherent in the change over from the use of bituminous to smokeless fuel, and all that it means to the housewife.

In the first place, the industry must be able to assure the consumer that the smokeless fuel will be available and at a low cost. In the second place the installations burning smokeless fuel must be efficient and as

attractive as the old coal burning grates, and they must be easily and readily installed at a low capital cost. Reduced to the simplest terms, we must ask ourselves how a local authority is to persuade a housewife who has burned coal in an open grate all her life, suddenly to have the grate removed, a new and perhaps slightly more complicated one installed at some small cost to herself or her landlord, and then to fire it with a fuel which is twice as bulky as coal and which leaves a greater bulk of cinder? Even if this is to be done at no cost to herself, the local authority and the landlord bearing the cost, will she welcome the change?

Already much has been done to help her to get over the initial doubt. The appliance manufacturers have made a very careful study of the problem, and all kinds of smokeless fuel burning appliances are available. Study has been made of easy installation and of heating capacity. In particular the need to provide in one installation radiant and convection heat are to be noted. Study of reflected heat surfaces to reinforce the direct radiant heat of the open fire, and several installations incorporate space which creates convection currents to be sent round the room. Manufacturers claim that a saving of 35 per cent. to 50 per cent. fuel is achieved against the oldest installations. Greater comfort, and greater economy achieved with a cleaner fuel and without smoke are words which will tempt a housewife. She will get rid of the old grate which had to be blackened, and readily accept the new installation with its porcelain enamelled bronze gleaming front. And where she is told that an improvement grant will assist in the cost of providing the back boiler behind the open fire and give her a good supply of domestic hot water, she will not deny that the new installation is worth while. If manufacturers continue the trend of investigation that they have been encouraged to take by the Solid Smokeless Fuels Federation, the Coal Utilization Council and Women's Advisory Council on Solid Fuel, they will do much to get the new situation accepted.

But one snag still remains. This new smokeless fuel which the housewife is being forced to use is twice as bulky as the coal she was accustomed to. Where is she going to put it? Already her fuel store is likely to be too small. Storage is a problem that is probably too often neglected.

The following table shows approximately the space for one ton of each of the solid fuels most used for domestic purposes:—

Anthracite	. . average	40	cubic feet per ton
"Phurnacite" . .	,,	40	,, ,,
Coal . .	,,	45	,, ,,
Hard Coke . .	,,	75	,, ,,
Gas Coke . .	,,	80	,, ,,
"Coalite" . .	,,	90	,, ,,

In areas where conversions take place, and inadequate room is available, the aim should be to provide for at least one month's supply of fuel under winter conditions of use. With an open fire using up to $1\frac{1}{2}$ cwts. of coke a week, a four weeks' supply would mean the storage of 6 cwts. In cases where the appliance is designed to heat hot water or radiators consumption may go up to $2\frac{1}{2}$ cwts. a week. The Coal Utilization Council recommend minimum storage for flats as follows:—

	Coal	*Coke*	*Coalite*
Open fire . .	14 cu. ft.	24 cu. ft.	28 cu. ft.
Multi-duty appliances (10 cwts.)	23 cu. ft.	40 cu. ft.	45 cu. ft.

The provision of fuel storage of a size of about 3 ft. x 4 ft. x 3 ft. 9 ins. to each dwelling is an essential part of the conversion programme.

Opportunities are available through slum clearance and redevelopment programmes for the conversion of whole blocks of residential property consisting of rows and rows of cottages each pouring out its smoke into the grey atmosphere, into neighbourhoods where homes are heated by smokeless fuel and where the residents may look out on a blue sky. These opportunities will surely be exploited.

CLEAN AIR AND FAMILY HEALTH

by

Miss J. M. Akester, S.C.M., H.V.Cert.D.M. (London)

Nothing is of greater importance to the housewife than the health and happiness of her family. All her efforts, budgeting, shopping, cooking, cleaning, making and mending are directed towards the achievement of this dual aim. The two things are generally linked together in her mind, because, although a happy family life can be maintained in spite of sickness and resultant hardship, she knows that any sickness means sorrow in some degree, and that happiness is more difficult to achieve if she, her husband, or her children are the victims of ill-health.

In spite of all the provisions of the National Health Service, illness still causes a major crisis in most families. The salaried man can generally count on a period of sick leave on full pay, but a long illness brings the worry of weeks on half-pay, and then no pay at all. The manual worker finds his weekly wage reduced to sickness benefit at the onset of illness, with the possible supplement of national assistance. In either case, it is the housewife who must devise ways and means of economizing and, at the same time, nurse her husband cheerfully or visit him in hospital, concealing her anxiety so that his may not be increased. A sick child means worry and trouble for both parents. Whenever possible, children should be nursed at home, but this means the strain of sick nursing and housekeeping fall heavily upon the mother. If hospital care is unavoidable, most parents make every effort to avail themselves of opportunities to visit daily. They go willingly, but the visits are often made at great cost to the mother who must plan for the care of her household and other children. Often too, the expense of fares causes considerable hardship.

Whenever the housewife is herself sick, the disaster from the family point of view is greater than when any other member, even the wage earner, is the sufferer. A good home rapidly becomes comfortless because even the most domesticated men can seldom attain the same standard of housekeeping as their wives, in addition to their daily work. Adolescents go out into the streets because home loses its attractiveness and the care of young children presents an almost insoluble problem. If they cannot be cared for by relatives or friends there remain the two alternatives of a home help or a residential nursery, and in either case payment must be made. Recent research has shown the disastrous results which may follow the separation of young children from their parents, particularly their mothers, and it is now known that prolonged separation may cause permanent damage to the child's developing personality.

It is, therefore, right that the housewife should accept the maintenance of family health as one of her chief responsibilities, and with this end in view, most housewives would choose to live where there is clean air. While it is not easy to prove that a polluted atmosphere is the cause of any particular illness, there is a general conviction that smoke laden air has a bad effect on health. Many requests are received for rehousing because some member of the family has asthma or bronchitis. Health visitors are sure that there are more snuffly, wheezy babies in the dirty areas of a city than on the outskirts. Unfortunately, it is in the poorest and dirtiest districts that there are always many contributory factors to ill health as well as polluted air. Property is likely to be old, ill ventilated and damp. Food and clothing may be unsuitable or inadequate and standards

of personal and domestic hygiene may be low. However, in spite of these difficulties, there is now definite evidence that air pollution alone has an adverse effect on health.

Air Pollution and Disease

One of the commonest diseases of childhood in the 19th and early part of the 20th centuries was rickets, with its resulting deformities. On the continent it was known as " the English Disease," and in this country the typical bowed legs due to severe rickets were known as " Leeds legs." Rickets is caused by a combination of inadequate diet and lack of sunlight, and it was naturally most common in the industrial areas where the sun's rays failed to penetrate the smoke haze. Even as recently as 20 years ago it was unusual to see children in the poorest districts who were completely free from any sign of rickets. Now, a better knowledge of nutrition, changed fashions in clothing, and the use of artificial sunlight when necessary have almost stamped out the disease. Nevertheless, the deformed legs of middle-aged adults still serve as a reminder that preventive measures must be maintained. And that these include the provision of a clean atmosphere.

Apart from rickets, it seems that the various chest conditions are most likely to be caused or aggravated by polluted air.

The Beaver Report makes several references to the effect of atmosphere on health, e.g. " Whilst scientific evidence about the effects of air pollution on human health is incomplete, enough is known to make it abundantly clear that it is injurious to both physical and mental health. It fosters disease and can cause death." In another paragraph, attention is drawn to " the clear association between pollution and the incidence of bronchitis and other respiratory diseases," and statistics are given which show the excessively high death rates from bronchitis in England and Wales as compared with those of Denmark, Sweden and Norway (2·2 per 1,000 males in Denmark in 1951 and 107·9 per 1,000 males in England and Wales in the same year). " Not all the excess can be attributed to air pollution," the report continues, " since other factors, e.g. climate or housing conditions play a part, but in general, it is the industrial towns liable to a heavy pollution, that have the heaviest death rates."

The London fog of December 1952 is known to have accounted for some 4,000 deaths. At an earlier date, January 8th, 1949, W. P. D. Logan gave conclusive evidence in the *Lancet* of the relation between fog and deaths from bronchitis and pneumonia. During the week ended December 4th, 1948, the 48th week of the year, there was fog in London and Dr. Logan published statistics comparing the number of deaths during this week with the number during the same week in other years, and with the number during other weeks in the same year. He also gave a comparison of deaths from certain diseases during the 44th to the 51st week of 1948. The following figures are quoted from the *Lancet:*—

Deaths in London in the 48*th week of the Year.*

1945—	739
1946—	778
1947—	721
Week of fog 1948—	1,019

i.e. 20—30 per cent. increase.

Comparison of Deaths from Certain Diseases. 1948.

Week	*44*	*45*	*46*	*47*
Bronchitis . .	63	57	68	73
Pneumonia	32	42	46	29

Week	**48**	*49*	*50*	*51*
Bronchitis . .	**143**	103	88	55
Pneumonia	**73**	71	67	51

In addition to the respiratory infections it is now thought that there may be some link between air pollution and cancer of the lung.

Paragraph 16 of the Beaver Report states:—

" The comparative death rates for urban and rural areas generally suggest that pollution of the atmo-

sphere may be a factor in the production of cancer of the lung."

Air Pollution and Fatigue

One of the chief predisposing factors in the cause of disease is fatigue. It is the overworked, overtired individual who readily succumbs to infection. The housewife in the city is particularly prone to fatigue, especially if she has a high standard of cleanliness. Washing, cleaning, dusting and polishing occupy much more of her time than they would if she lived in a smoke-free district. This means that she has less time for leisure, or has to work much harder and more quickly if she is to allow herself any spare time. The deposit of solids from the atmosphere during 1954 was 354·14 tons per square mile in the centre of Leeds and 109·14 tons per square mile at Temple Newsam on the outskirts. In other words, housewives in the centre of the city had to remove 3 times as much dirt, soot and grime in order to maintain the same standard of cleanliness as housewives on the outskirts. One woman, recently rehoused from a slum clearance area, remarked that her net curtains now kept clean for six weeks, whereas in her previous house they had to be washed every week. In the centre of the city, windows need cleaning at least once a week, brass tarnishes quickly, paint and woodwork are daily covered with smuts. Housewives in some parts of Leeds say that the deposit can be so heavy that footsteps on linoleum sound " as if one is walking on sugar." Children, with their magnetic attraction for dirt, are never clean, and both they and their clothing need constant washing.

This daily removal of dirt constitutes the most laborious part of the housewife's work. When it requires too much of her time and energy, she is tired before she is able to begin the more interesting and less exhausting duties such as cooking or sewing. Unless she has considerable strength of character, outside interests are sacrificed altogether and finally, she ceases to be concerned about her own appearance because she is " too tired to bother."

Air Pollution and Diet

Families in the low income group have added anxieties in dirty areas because of the cost of soap and detergents. Some of the money needed to provide an adequate diet must be diverted to cleaning materials. Moreover, the constant washing of garments, curtains, etc. increases wear and tear, so that more money must be spent on replacements. Another source of expense is interior and exterior decorating. Paint and wallpaper are quickly dirty and shabby and in the West Riding " Christmas cleaning " which includes the complete redecoration of the living room, is not merely an annual rite demanded by local custom, but an annual necessity.

Generally, it is the housewife who bears the heaviest part of the burden of planning the family income and of providing for cleanliness, clothing and food. If the income is small and the family large, it is highly probable that she herself will have less than her fair share. Her coat will be worn and threadbare and her shoes will leak in the wet weather, because of the need to keep her husband and children clad and shod for work and school. Above all, her diet will suffer more than that of her family. Not infrequently one hears the comment " Oh, I can always make do." The housewife sends her family off with a good breakfast, and then " makes do " with a cup of tea and anything left over. Some stand the strain, but others pay the price of overwork and inadequate feeding. Subnormal health is the lot of many city housewives and anaemia a common ailment. These tired, undernourished women are susceptible to all types of infection, influenza, coughs, colds, sore throats, and to the disease which is still one of our most serious public health problems—tuberculosis.

Fatigue and undernourishment rank high amongst the predisposing causes of tuberculous conditions.

Air Pollution and Problem Families

Much has been said and written in recent years about "problem families." Villages and country towns produce their quota, but the greatest number is found in city slums. Poverty drives them into the poorest and most dilapidated property, where they live in unimaginable squalor. Generally, the parents are of poor or unstable mentality and the mothers are often in poor physical health. Generally, too, the family is a large one, and each succeeding child adds to the parents' difficulties. The chief reasons for the entry of any family into the "problem" group are, no doubt, the ignorance, incompetence, and low mentality of the mother, but her low standards are further depressed by life in a dirty atmosphere. The average housewife maintains her family in a reasonable state of health and cleanliness whatever the conditions, but just as some are physically unequal to the strain, and succumb to illness, others prove to be mentally incapable of conforming to local standards in the face of difficulties. It is true that some families seem to be unable to live decently wherever they are housed, and that they can rapidly convert good accommodation into slum dwellings, but there are many border-line families, who will just manage, provided conditions are not too difficult. Confronted with the dirt and grime in the centre of a city they are completely overwhelmed. The city housewife's daily battle with living conditions demands keen wits. If she is not endowed with at least average intelligence, she is easily defeated. Air pollution cannot be held responsible for the presence of problem families in our midst, but it certainly contributes to the squalor in which they live, and for some of the weaklings in the community it may well be the proverbial last straw.

The Psychological Effect of Clean Air

The tonic effect of sunshine is recognized by everyone. A bright sunny morning alters the outlook and expressions of the hurrying crowds on their way to work, and cheerful greetings are readily exchanged. In the British Isles, sunshine is precious and should not be squandered, but, unfortunately, the cities have many days on which the sun never penetrates the smoke haze. Most people know the familiar experience of approaching London from the South coast, leaving brilliant sunshine and arriving under overcast skies, or descending from the clear air of the Pennines to the industrial areas on the East or West, with their pall of smoke almost hiding them from view. Under the pall, men, women and children live, work and play, unconscious to some extent of their own deprivation, but sun-starved nevertheless. Sunshine brings people out to their doorsteps for friendly conversation and into the parks to play with their children, or, if the family budget permits, for bus rides into the country. For the housewife, it "shows up" the dirt, but also emphasizes cleanliness, so that the daily round of scrubbing and scouring seems more worth while.

It is much easier to be a prey to depression and gloom on a dull grey day, and much easier to throw off depression when the sun shines.

Almost half the hospital beds in the country are allocated to mental illness, and about one person in every 12 suffers at some time from some form of mental ill-health. It does not seem, therefore, that we can afford to overlook or waste any of our assets which may help, in some measure, to counteract the strain of modern living, yet we allow polluted air to obscure the sun to such an extent that the intensity of diffuse daylight in the centre of Leeds is only 40 per cent. of that of the surrounding countryside. No doubt similar conditions could be found in any of our industrial areas, and in any of our large cities families must be feeling the effect of this deprivation of sunshine.

The accumulation of evidence seems to prove that clean air might have a considerable effect on the incidence of both physical and mental ill-health.

Less sickness would mean that less working days would be lost and so productivity would be increased, and at the same time the enormous cost of the National Health Service would be reduced. At the family level, better health would contribute to stability and security, and would relieve the housewife of one of her greatest sources of anxiety.

Discussion

Dr. W. R. Martine (Midlands Joint Advisory Council for the Abatement of Smoke and Atmospheric Pollution), in opening the discussion, complimented the speakers on their able presentation of such excellent papers, and said that the session was a direct sequel to the morning's session. As had already been pointed out, the Clean Air Act brought the abatement of atmospheric pollution directly into the home for the first time, except in those few local authority areas in which there were already smokeless zones. Thus, for the first time, the housewife was implicated. That development brought the subject directly within the sphere of the Medical Officer of Health in his programme of Health Education, and he thought it was worthy of mention from the platform that not only had they had a Medical Officer of Health chairing a session, not only had they had three papers given by doctors, but that more than a tenth of the total delegates to the conference were medical men. That was a very striking occurrence in the history of the Society.

Dr. Martine said that there were three points he wished to mention in regard to the papers. Firstly, he was very glad to have heard his fellow Scot speak so ably on behalf of the housewife. Secondly, the question of storage of solid smokeless fuels. For all they had heard about fuels in the past two days, the second speaker's reference to storage had really been the first ventilation of that very important aspect during the conference. Certainly cost and distribution were important, but he submitted that storage was just about as important. They could not really obtain, or operate, smoke-control areas and smokeless zones unless such provision was made. It was a problem that should have been faced by local authorities long ago; it was one that must certainly exercise their attention now and at once. On the question of Birmingham's redevelopment areas, he was not representing Birmingham on this occasion at the conference, but his Regional Advisory Committee, but he could assure the speaker that the smokelessness of the redevelopment areas in Birmingham was a matter which had not been lost sight of.

Finally, there was one other point that he had not seen emphasized, and that was efficient installation of the modern approved fire-grate. There was a real need for an extension of the training of the builder in installation. He knew that the Coal Utilization Council, jointly with the Women's Advisory Council on Solid Fuel, and in association with the Fuel Technology Advisory Committees, had tried to do something about it, but in his own personal experience he had two such grates burning a solid smokeless fuel, which would be nameless, but in both instances, although installed by a builder reputed to be one of the best in Birmingham, neither of them had worked properly. His wife had been so dissatisfied with the first that she had hacked it out and installed it properly herself. Then, when the second grate had been put in some time later, and again incorrectly, she had dealt with that also. To be efficient, these grates must be properly installed, and the average builder had not a clue about it as yet. Finally, Dr. Martine concluded, experience had shown that the user required education in the means to get maximum efficiency, and it was absolutely essential for the local authority to follow up with demonstration and advice to the tenant, once a modern approved appliance had been installed.

J. H. Orr (Coalite and Chemical Products Ltd.), whilst congratulating Mrs. Courtney, said that he was shocked at her statement that summer prices did not apply to smokeless fuel. During the last week of April the makers of Britain's pre-eminent smokeless fuel had introduced summer prices which would apply in the North until October 31st and in the South until November 30th.

Councillor Miss Margaret Smith (Merton and Morden) said that the public was

rather at the mercy of rival firms, in choosing a modern appliance for the home. In choice, size, and installation, there should be an advisory officer to whom purchasers could apply, so that they were ensured good results for their money.

The same advisory service should be available with regard to appropriate fuel, so that the householder would not have to travel by way of many experiments to his ultimate goal.

If there was a distinct province for women public health inspectors as apart from men, it could surely be in the staffing of that service, since women were naturally concerned with home comfort. Their recruitment for the work would be sensible, and would add strength to a department which was at present sadly depleted.

J. T. Scott (Yorkshire Electricity Board) referring to Miss Ledeboer's paper where it was stated that "heating a dwelling . . . can be done by electricity but even Electricity Boards will not deny that this is expensive," said that it should be made clear that that related to continuous heating. For intermittent heating, electricity was cheap. Even with regard to continuous heating, however, the statement could not be accepted in the light of present knowledge. A paper by Mr. J. W. Moule, available to members of the Society, gave details of electrical floor warming for building heating. There were theoretical objections to floor warming, but the fact remained that, over a twelve-month period, including the severe months the previous winter, the tenants of a block of flats at Kirkcaldy heated by that method had been able to obtain a full lighting and heating service (lighting, heating, cooking, water heating and small appliances) at an average cost of 14s. 3½d. per week. That figure was slightly less than the average national expenditure on fuel and light, but provided better than average standards of heating and water heating. At the present stage of development it seemed that the method was most appropriate to flats but it did appear to be one of the ways in which electricity could contribute economically to Clean Air.

Mr. Scott said that Miss Ledeboer (in introducing her paper), had referred to the open fire. Frequently during the conferences there had been references to the high price of solid smokeless fuel. It seemed obvious that increased demands for coke would cause an increase in the price of coke relative to coal because new plant would be required at present-day prices and less suitable coal would have to be carbonized. That could only be offset by dispensing with the open fire and using more efficient appliances, namely closed stoves. The initial cost would be higher, but reference had already been made at the conference to the substantial return on capital expenditure; the return would still be very high. The reduction of the total quantity of fuel consumed would also reduce sulphur pollution.

F. J. Ralph (East Midlands Gas Board) said that he supported Miss Ledeboer's plea for adequate coke storage space in new houses. Many houses being built at the present time, although fitted with the new coke burning appliances, were ill-equipped for storing the necessary amount of coke. Unless adequate storage was provided, consumers might find themselves without fuel during winter peak periods when bad weather and illness caused coke merchants' delivery to be extended.

Councillor Mrs. A. M. Ott (Deptford) said that she used smokeless fuel at home. Unfortunately, she had been told that supplies of smokeless fuel were being directed to London's only smokeless zone —in the City—and she was now unable to obtain supplies. She said that it was an important problem, and she hoped that subsequent speakers might be able to suggest a way in which it could be overcome when further zones were being planned.

Councillor W. Newman (Ipswich) said that while the experts to whom he had listened were correct from a theoretical point of view, he wondered how matters would work out in practice. He emphasized that far too much inefficient apparatus was still on sale in the shops. It was no use telling the housewife who installed a modern grate that, as a result of fuel saving, she would recover the initial cost. A modern grate could often be kept alight throughout the night. That did not apply to the older type of grate, and the cost of the extra comfort would have to be met.

The suggested arrangements for meeting the cost of conversion would mean endless argument as to who was liable for payment. In that connection, it was important to remember that many small landlords and owner-occupiers would not be able to afford the extra expense involved.

Extra staff would then be necessary to deal with the consequent forms and endless correspondence. Moreover, where the problem of pollution was most acute, local authorities would then be saddled with heavy expenditure, followed by the inevitable rise in rates. That might meet with opposition from the Finance Committee, who generally offered stones when asked for bread!

W. H. Wattleworth (C.P.H.I., Liverpool) said that he had two points for consideration—(*a*) Education Propaganda, and (*b*) Employment of Lady Public Health Inspectors.

He was impressed with Mrs. Mary Courtney's paper, particularly regarding the education of the housewife. Mrs. Courtney had referred in her paper to the wise housewife who was conversant with statistics and economics, but he was more interested in the unwise housewife content to burn coal indiscriminately without consideration of any factor other than obtaining heat for comfort or cooking. There was no doubt, he went on, that in the domestic field propaganda would be the main spearhead in attacking the problem and should be modelled on the first class approach carried out in respect of diphtheria immunisation.

Legislation would not assist greatly, infringements would only occur if domestic smoke was of a density of Shade 2 on the Ringelmann Chart, and therefore would be confined within the smoke control areas. The cost of works involved in conversion would also be a deterrent, for local authorities had already failed to implement the patch and repair clauses of the Housing Act due to the initial cost involved.

Furthermore, it would be very difficult to interest the housewife in modernizing an old grate when she was living in a house without hot water, with a defective roof, inadequate sanitation, obsolescence and all the other discomforts.

With regard to the employment of Lady Public Health Inspectors, Mr. Wattleworth questioned whether they had forgotten that already in the Public Health Department there was a team of efficient and conscientious female workers in the Health Visitors' Section, and further introduction of women in the inspectorial staff was to be deplored. The work would have to be selective, causing dislocation and irritation, and perhaps even animosity by the male inspectorial staff condemned to carry out routine tasks of slum clearance and sanitation, while the lady inspectors would be employed on food hygiene or the welfare clauses.

Miss Mary Leigh (Women's Advisory Council on Solid Fuel), referring to an earlier inquiry as to the possibility of women being trained as Public Health Officers, said that there was already such an Association and in fact they were represented on her own Council.

She felt that they were very fully employed in their own field and, as advice on fuels and appliances required specialized knowledge, it would seem better that the work should continue to be carried out by the staff of the Women's Advisory Council on Solid Fuel, whose main function it was, even if it required additional staff.

Councillor M. Eales (Dagenham) said that the Conference should adopt a more realistic attitude. The very high cost of all smokeless fuels and appliances appeared to be ignored or accepted as inevitable. If public opinion was to be won over, the price factor was of supreme importance. The local authority he represented was operating a small district heating scheme, and the excessive cost of maintenance and operation was a constant worry to the authority and the tenants.

Dr. C. G. K. Thompson (M.O.H., Wakefield) began by congratulating the Executive Council of the Society on arranging such a successful Conference. He said he had not intended to speak, but he felt that, if for no other reason than to congratulate the Executive Council on arranging a Women's Session which was so successful and so really down-to-earth, then he had done what he felt was his duty.

He said that, in his opinion, one of the most important things in dealing with smokeless air and clean air, from the domestic point of view, was for the husband to persuade the housewife that the open fire had gone for ever, and that burning bituminous coal was a wasteful and harmful method of heating a room. He said that he long since converted his own wife, and fifteen years ago he had exchanged all his open fires to the closed, free-standing coke-burning appliances, and the result of that policy had been efficiency in fuel consumption, and a really warm house.

Dr. Thompson then went on to speak of coke, mentioning that the coke prices had a basis. Although at one time coke had been considered a waste-product of

the Gas Company, and had been sold at any price in order to get rid of it, it had now come to be regarded as a valuable means of heating, instead of coal.

In his own town, he had arranged with the City Council for a conference of persons in the West Riding interested in smokeless fuel, to discuss the possibilities of using coke, and of making coke more easily and generally available, as at that time it was not, in the City of Wakefield. As a result, and due to the enterprise of the Gas Company and the Coal Board, through the Solid Smokeless Fuels Federation, coalmen (who used to eschew dealing with coke) were being allowed the same bonus on coke as they were allowed on the sale of coal. One of the causes of the high price of coke was the repeated handling of the fuel, although he felt that probably a good deal of the price was accounted for by overheads, which were not shown. It might be that coke was subsidizing something else. One quarter of the weight of good coal went in by-products of great value—drugs, tar, etc.—the rest was coke.

Dr. Thompson then went on to deal with the question of coal agents, who, in the North, were purely hauliers. They were simply the means of transporting the fuel to the householder, and did not know anything about the product they were selling, and were unable to give advice on the proper methods of burning, or the most suitable fuel to purchase. That was all very well when coal was easily burnt, and there were open fires. But as coal was becoming so expensive, and they were realizing how dirty and wasteful it was, it was essential that the man from whom they bought their fuel should be able to give advice about it, and about whatever other form of solid fuel was obtainable. At present, in his City, no coal agent had any information service. Further information was needed also about solid smokeless fuel burning appliances, and there it would be helpful if ironmongers would make themselves conversant with the different types of appliances, and the conditions under which they burned best, so as to be in a position to help members of the public to chose the most suitable appliance.

Dr. Thompson said he wished to thank Dr. Martine very much for his contribution about installation. He himself had known of a modern coke-burning appliance being put in upside-down! Most builders had not the slightest idea of the reason for a fire burning, nor had many people, who just put coal on the fire. It was therefore very necessary to have some fuel expert who could say whether or not a chimney had sufficient draught, whether it was sufficiently warm to maintain its heat, and whether a fire would burn properly, and to advise people who stuffed up doors and windows that it was impossible to get a fire burning unless they allowed air to come in. He hoped that people would realize this, and that under floor draught control would be installed wherever possible. The free-standing fire was the only one which prevented draughts. Any open fire with a big throat was bound to have draughts, because of the great volume of air which had to be drawn up the chimney.

Alderman B. N. Young (Gateshead) said that one way of avoiding the difficulties associated with solid fuel and solid fuel appliances was for the architect to design houses without chimneys. When considering the cost of fuels other than solid fuel, many economies had to be considered. There was no need, for example, to provide means for disposing of the waste from the fires, fuel storage was unnecessary, and there was much less dust in the house. Ten storey blocks of flats had been built in Gateshead without chimneys or solid fuel heating. The wives in the families concerned had been rather disturbed when they went into the flats a year ago. Now, however, they were all agreed that they would not want to return to heating by means of solid fuel, and that they felt that the extra cost did not outweigh the advantages. He said that he thought that these other forms of heating would be most extensively used in future.

The Seventh Des Vœux Memorial Lecture

Clean Air : The Next Chapter

by

Sir Hugh Beaver

K.B.E., M.Inst.C.E., M.I.Chem.E., F.Inst.F., F.R.S.H.

I FEEL specially honoured by being asked to give the seventh Des Vœux Lecture this year. Two years ago I spoke at your Annual Conference on the eve of the publication of the Report of the Committee on Air Pollution. I am not sure that it is appropriate for me to make any more speeches in this matter. I have made too many already, for it is as I have said two years since my Committee reported, and with its report the Committee and its Chairman went out of official existence. I would, however, like as it were to sum up—to sum up at least so far as I am concerned. So this is virtually my swan song.

I have chosen as title, *Clean Air—The Next Chapter*, because I hope, as we all hope, that we have with the passing of the Clean Air Act indeed opened a new Chapter; and that as we turn the page of 1956 we shall not find that we are still in the old dreary tale of the last 30 or 50 or 100 years. In a paper I read in America in the beginning of last year I detailed the wearisome cycles of complaint, committee, report—complaint, committee, report, repeating themselves ineffectively over and over again. The purpose of that paper was to show how public opinion is the decisive factor. That moral is just as pertinent now. If we look on the passing of the Clean Air Act as a milestone, it is well to remember that we only reached that milestone by the force of public opinion. And if in time to come we are to look back on the passing of this Act as the beginning of a new Chapter, it will be because public opinion will have both required and facilitated the effective application of the Act. The mere passing of the Clean Air Act could mean little more than have meant various legislative and administrative actions in this respect in the past.

It is in that light that I want today to make some sort of a national survey. Wars are generally supposed to be normally, though of course not always, won, or lost, in some one or other decisive battle; and there is generally no doubt about the decisiveness of a decisive battle. But there are no decisive battles in the war against air pollution—or at least it will be only in long retrospect that it will be possible to recognize that any particular action was in fact decisive. So let us not think today that you or we have won a great victory. It rests on the future and on what we make of the future, to decide whether it has been a victory; and whether the new Clean Air Act does in fact open a new chapter.

Now I want to make it quite clear that anything I may have to say about future action is not intended in any way to be mapping out a future for the N.S.A.S. I would not wish to seem to be either criticizing what your Society has done in the past, or advocating what it should do in future. Doubtless it has had and still has a part to play—how big, how important, must depend in large extent on your own selves. But doubtless too many others have a part to play. This is a matter in which there has to be a

surging tide of opinion and intention over the whole country, a tide that knows no ebb and which involves all interests and all individuals.

I am not going to start with any detailed comparison between the position—legal and administrative—before the passing of the Clean Air Act and after. I am not going to reiterate the new powers and the new action that the Act makes possible. Still less am I going to indulge in a jeremiad on what the Act does *not* contain. I am going to assume that you all have these matters at your fingers' ends. Whether or not it falls short in this or that respect of what you, or any of us, would have wished, it does provide scope for a great deal of action. My question today is how will it be operated, and what can we do between us to ensure that action is fully taken. We may properly remind ourselves that even the feeble legislation and powers of the past were not anything like exploited to their full. The same can happen again all too easily.

I want then to see:

What is the most that can be made out of this Act;

What has to be done to secure that the most is indeed got out of the Act;

What other action remains for us and/or Government to do to complete the campaign.

The Act starts with furnace smoke. Let us do so.

Furnace Smoke

So far as furnace smoke is concerned the whole responsibility now rests fairly and squarely—and most appropriately—on the shoulders of the local authorities. This was my Committee's recommendations which the Government accepted; and I have heard no criticism anywhere as to the decision. That in other directions some local authorities have claimed that they should have greater powers is not relevant to this issue of furnace smoke. And if furnace smoke is not to a very large degree hereafter controlled, the fault will or should be on the local authorities. But it will not be plain sailing; there are as I see it four serious difficulties.

In the first place there is the question of staff. My Committee referred to this in their report and I have myself elsewhere dealt with it at some length. All sanitary inspectors are agreed that it is better to carry people with you than to have to use, or threaten, sanctions; to persuade, rather than compel, the user of a furnace, whether industrial or commercial or private individual; if necessary to show him how the appliances or the fuel can be made to work satisfactorily. Only in the very last resort will compulsion and prosecution be used. But all this means staff. The field of observation and education and control is vastly increased and most local authorities are in no position to take on this new responsibility.

I had sent to me a few weeks ago an account of the debate over the latest annual budget for air pollution control in Los Angeles—which I may say amounted to $4,000,000—in the course of which the Chief Air Pollution Officer pointed out that " control of air pollution is not a problem that can be solved with finality; in the nature of things it is a continuous problem. If smog," he said, " is not to be with us permanently, permanent methods of preventing it will be." One must accept that; and where is the staff? In regard to smoke inspection I have before this stated that it is not in itself a profoundly scientific job; and I do suggest that inspectors of a lower level of qualification than a sanitary inspector could be used here as they are in the States completely effectively.

The second difficulty that I foresee is on this matter of the definition of dark smoke. I know that no one wants prosecutions, but in the end some prosecutions are inescapable; and if the courts develop an attitude of criticism or scepticism as to evidence tendered whether or not based on Ringelmann Chart 2 and comparisons with it, or of any other standard of measurements that may be evolved as

the result of the present efforts of the British Standards Institution, then a serious hole could be driven in this vital part of the Act. What would be ideal, and what I am quite sure is ultimately not unobtainable, is some form of factual registration of dark smoke. I have myself had some experiments carried out in an attempt to find some means of using photography scientifically instead of emotionally, as is the general attitude now. They have neither gone very far nor given much ground for hope. But this problem requires serious attention.

Again there is the as yet unsolved problem of infringement by night. But here I am sure that local authorities should be prepared to use Para. 4 of the Act, that is to say to persuade the Minister to use it, wherever there are good grounds for believing that infringement by night—though not by day—may be taking place. I think there should be some general agreement among local authorities as to what degree of measurement and recording would be adequate and reasonable. The British Standards Institution is I know preparing standard specifications for measuring instruments. These can be elaborate and costly, or simple and cheap. It may be that from the smoke prevention point of view the latter could be sufficient. My point is that a wide variation of attitude among local authorities, as to what is reasonable and adequate, will jeopardize ministerial action.

Finally there is the " unsuitable fuel " defence of Para. 1 (3) (c). My Committee did not believe in the alibi, and I hope that it will not be able to establish itself as a routine defence. I suggest that there should be a testing station, or more than one testing station, available where any coal so pleaded would be tried out in sufficiently comparable, or at any rate fair, conditions. That would put the claim to practical trial, and I think it would not often be required.

In all this there is as I see it scope for a certain amount of co-ordinated thinking and some research and experiment on the part of the local authorities. I suggest that they should have a small Committee or Working Party of their own to draw up a code of practice for themselves. The more they agree on their attitude and practice the more powerful will be their impact.

This same body could study and agree for itself—though the final word does not rest with them—the standards that they feel should be adopted in regard to the heights of chimneys. There is scope too, I feel, for such collective thinking in regard to the requirement of Para. 3 that new furnaces shall " so far as practicable be smokeless when burning fuel of a type for which the furnace was designed." Even the most experienced of Smoke Inspectors and Borough Engineers may find this not always an easy problem; and what about the great number of smaller local authorities? There seems to me to be every argument for combined thinking and study of this sort by the local authorities. This would reduce duplication of effort and assist the less well equipped local authorities; for to a large extent the smaller local authority has not the technical means to carry out these tasks. Moreover if the local authorities are to be really something more than merely the Minister's agents, they must be fully informed technically and scientifically. Any action such as I have suggested is completely legalized by Para. 25 (1) (a) of the Act.

Let us turn to the other side of industrial smoke: the special cases referred to in Para. 17. The intention of the Air Pollution Committee was that all industrial air pollution that because of technical difficulties in the prevention of dark smoke, grit, dust, etc. could not be dealt with under the general provisions of the Clean Air Act, should be subjected to a continuous and sharp challenge by a central inspectorate; to be composed of skilled and experienced chemists, metallurgists and fuel technologists. So long as no certain technical method is known to prevent any process being

a nuisance or a danger, then the "best practicable means" must be used; and in some cases, no means at all are as yet known. Now this means on the one hand adequate staff, and on the other effective direction of them. It is essential that both these factors operate. There are I think well over a thousand works which will come under the eye of the Alkali Inspectorate and many of them present pretty difficult, indeed so far intractable, problems. They can only be solved by research. Have the Alkali Inspectors the means of securing that adequate research and experiment is done? Certainly the means of research in industry, in research associations, in the D.S.I.R. exist; but will the Alkali Inspectorate have sufficient influence on these means? At any rate whatever the reason there are directions one could quote in which one may well doubt whether enough is being done.

The Act interprets "practicable" as you know, as "reasonably practicable having regard amongst other things to local conditions and circumstances, to the financial implications and to the current state of technical knowledge." Now what is going to be the practical application of this? As one reads through the Chief Alkali Inspectors' Reports one is struck by two types of remark. I will quote an example of each so as to make my point clear. From one report a few years ago I read:

"The national requirements of iron and steel are such as to necessitate the continued operation of the works (which are of course only referred to by a number) at high pressure although it is an uneconomic unit, which the owners would be glad to close. *It is understandable that the owners are averse to spending large sums on the works.*"

Or again in regard to two old power stations, "Complaints of smoke emissions from P.S. 70 and 72 were investigated. These are old stations which are used only at peak load periods and then as little as possible. The conclusion was reached that all reasonable steps were taken to avoid smoke emission."

The other type of remark is exemplified by the following, "Smoke and grit from coke ovens. There has been great activity in the building of new coke ovens and the replacement of old ones by modern batteries. Duplicate ascension pipes and gas collecting mains produce draught at each end of an oven and thus reduce the escape of smoke to atmosphere. The speed with which charging is effected is also an obvious factor and attempts have been made to accelerate the operation by improved designs of coal hoppers, the provision of vibrators and the fitting of charging lorries with rotating feed cables. Not all new coke ovens have been equipped with duplicate ascension pipes and gas collecting mains. Certain owners have refused to make this provision chiefly on the grounds of the additional cost of construction."

I quote these not by way of criticism of the Alkali Inspectorate, because indeed in many cases that they have dealt with in the past they have had no power to direct action. But now—at least if my Committee's views are followed—all these cases will be scheduled. If so then the suggestion I would like to make in regard to this sort of position is that in the case of old plant where it is considered uneconomic to take remedial measures on the grounds that the plant will soon go out of use, a definite time limit should be put to the acceptance of this argument. On the other hand in the case of new projects the plea of additional cost should be put into exactly the same perspective as is such a plea if advanced in regard to any other works where it may be necessary to protect the public, whether under bye-law or other statutory enactment, for instance the height of chimneys. It seems to me curious that when as is obvious great advances have been made in many directions, there should be no power, or the power if it exists should fail to be used—to require new plants to live up to the latest good

practice. I think one must look to the Alkali Inspectorate operating under the Clean Air Act to apply the same sort of treatment in such cases as is contemplated by Para. 3 in regard to new furnaces.

There is one more point that I would make in regard to these special cases, or scheduled processes, and that is I frequently notice in the Chief Alkali Inspector's Reports this sort of statement: " It is nevertheless not definitely established that the boilers are the main source of dust emission, there being other potential offenders in the locality." The Alkali Inspectorate owes much of its undoubted and beneficial influence to the fairness and friendliness of their approach; but I hope that the new Act means that we are departing in principle and for ever from the old attitude that unless the individual can be impeached for the whole of any nuisance, no action is justified. That is what bedevilled so much of the efforts in the United States, until public irritation forced the pace. Once more I must emphasize that I am in no way criticizing the Alkali Inspectorate; I am endeavouring only to survey what we between us all have to do in the future if we are going to turn the Clean Air Act into a real victory.

Domestic Smoke

Let us now turn to domestic smoke. I have elsewhere referred to, and others have detailed, all the various steps and the many interests involved in the creation of smoke control areas. At the risk of wearying you I will very briefly remind you.

There is the detailed survey of the proposed area, the calculations of the number and types of premises, houses, shops, offices, stores, etc., affected, the ascertainment of the different types of appliance to be converted and their number and the increased supplies of smokeless fuels required. The local authority obviously cannot make an order until it and the Minister are satisfied that the appliances will be forthcoming and the smokeless fuel or its equivalent available. Neither appliances nor fuels can be available unless their production has been planned and arranged and their use guaranteed well in advance. There is not only the question of production but that of distribution. Meanwhile there is all the statutory procedure of the making of the order, of local inquiry where necessary; securing of ministerial approval and the arrangement of finance; and then later the contracts for installing new appliances and so on. And in any large local authority's area various smoke control areas will inevitably be at various stages of establishment and development simultaneously. I will not enlarge; you can fill in the details for yourselves. But just consider all these and see what they involve and what Government Departments, Local Authorities, Industries, nationalized and private, and commercial interests are involved.

If it is the intention to secure the effective application of the Clean Air Act in 10 to 15 years, then, as has been pointed out over and over again, it is necessary to bring into operation smoke control areas in the so-called Black Areas at an average rate of something like 300,000 acres a year. As the start is bound to be slow and well below the average we must assume the normal sort of curve which would mean that from say the third to the ninth or tenth year from now new smoke control areas should be coming into existence at the rate of from 400,000 to half a million acres a year. This means the conversion of existing, or the provision of new, smokeless methods of space and water heating and of cooking in perhaps a million dwellings, shops, offices and buildings of every sort in a year, perhaps twice or more than twice that number of individual installations. If this is to be largely met by the use of smokeless fuel, coke and otherwise, as at the present stage of our knowledge it unquestionably must be, then it has to be produced of the right quality and at the right price at the rate of at least an additional million tons each year.

In the past the proposed creation of a smokeless zone has at any rate on one occasion been negatived on the grounds that the smokeless fuel and appliances were not available. But on the assurances of spokesmen of both the Ministries of Housing and Local Government and of Fuel and Power during the debates in Parliament on the Clean Air Bill that obstacle will no longer exist. There would be, we were told, sufficient smokeless fuel of one kind or another; or of gas or electricity. But in fact that will not come about by pronouncement only; it will not be the case unless a positive and co-ordinated programme of production and distribution is worked out. I am not sure where the responsibility for this lies, but I am sure that it is something that the protagonists of smokeless air must have under continual review. I have before suggested that the Institute of Fuel might well undertake to make an annual review of the known sources and position of all kinds of smokeless fuel, and the estimated requirements and resources for the following three years. You may think that such unofficial estimates would have too large a margin of error. They could obviously not be narrowly accurate; but they should be able to show with fair assurance the trends that are likely to develop from the known position in any year. Unless this information is assembled and made public, it seems to me impossible for local authorities or fuel merchants or appliance makers or the public to know where they are or how to make their plans. It may be that a blueprint of the clean air programme for the next five years is in active preparation somewhere, presumably in the Ministries concerned in England and Wales and Scotland. It may be that all the local authorities were being invited to submit their proposals for action over the next and following years, and that the resulting requirements are being calculated. It may be that a review has already been made of the availability of smokeless fuel in all the principal areas of the country next year and in 1958 and 1959 and 1960; and all the necessary steps being taken to fill any gaps. At any rate that is the action that one would expect to see being taken, if anyone or any authority intends to see that the Clean Air Act shall work. And it is not only necessary that such action should be taken, but that everybody should see that it is being taken and know the facts and figures.

Joint Consultation

Before I finally leave these subjects, I would point out that here too there is, as I believe, opportunity and need for joint consultation by the most experienced local authorities. They have to have both the will and the knowledge and the power to plan and carry out their programmes of smoke-control areas. Unless the local authorities know how to satisfy the local voters they will make little progress. They must know what good coke or other smokeless fuel means, what it should cost, what servicing is required and what types of appliance are going to give satisfaction. Unless they know all this and secure that their people get them, the whole scheme will break down in a storm of complaint and protest.

I want to turn now for a while to some of the things that the Act is not going to do; where it leaves things largely as they were, mainly because for one reason or another the means and the necessary knowledge to deal with these things do not exist. As has been pointed out over and over again, neither the Air Pollution Committee's Report nor the Clean Air Act attempted to cope with the problem of toxic gases, and in particular with the all prevailing sulphur dioxide. I have heard it claimed that Paragraph 17(3) of the Act gives the Minister power to schedule SO_2 in a general way among the noxious and offensive gases. I cannot believe that that would be seriously argued, but even if action were so taken it would in present circumstances and on our present knowledge be a dead letter. We may as well be honest and admit that. But I think our Report made

our position and our view abundantly clear. We considered that these toxic gases were a problem to which all the resources of research and experiment must be turned—medical, chemical, mechanical, administrative. We were struck and I still am struck by the gaps in our knowledge—as to the effects of toxic gases, as to the reasons for these effects, and as to the means of preventing or alleviating those effects. We were struck too—and I am not aware that the position is any better now—by the lack of co-ordination between the efforts of different enthusiasts and investigators. We pointed out for instance that the clinical work by a few hospital doctors and general practitioners was apparently hardly linked at all with such medical research work as was going on—and that any chemical research work was unlinked with either. I believe that an inter-departmental committee has since been collecting and assessing all the research problems connected with air pollution—both the work in hand and the work that needs to be done. That seems an excellent step, and if it has reached such a stage as would permit the publication of the results, then I think that this should be done. But it does seem to me that this is not a matter that can be adequately dealt with on a departmental basis alone, and I hope that that is not intended. This matter of research, and I mean programmed objective co-ordinated research, on the question of toxic gases is of vital importance. I believe that the Royal Society of Health could do a great service by arranging a conference designed to survey the whole field and to open up all the sources, and so stimulate action.

Road Vehicles

There is a related matter in which the Act brings no improvement and that is in regard to the control of road vehicle exhausts. This is becoming the primary objective of attack in many cities in the United States and particularly of course in Los Angeles. Very large sums have already been spent both by motor manufacturers and others on the problem of the prevention of toxic motor exhausts. Is adequate research being done in this country? I suggest that the approach to this problem should be similar to that followed in regard to the scheduled processes, namely of continual informed challenge, and the insistence on the incorporation of best known methods—as soon as these are established—at least in all new motor vehicles. My Committee recognized that this evil cannot be cured by police control; it still remains in the category of aspects of air pollution that still have to be tackled. This road vehicle problem is bound to become of increasing seriousness, and I am bound to say that I do not think that present regulations and present responsibilities are going to cure the evil.

I am not going to attempt to show in any further detail what sort of problems and what sort of action lie before us if we are to see the Clean Air Act effective and if we are to consolidate this first advance and set out to storm the next position. If I have not so far succeeded in convincing you—even supposing any action on my part to be really necessary with such an audience—then no further elaboration by me would be effective. What at all times impressed my Committee and what I believe must impress you and everyone who studies this question is the complexity of interests involved, It was for that reason that my Committee set great store by the creation of a Clean Air Council; and a Clean Air Council has been established by the Act. I think it is worth while re-stating what my Committee had to say:

" For purposes of central administration, air pollution is a matter with which several Government Departments are concerned—the Ministry of Housing and Local Government, the Ministry of Fuel and Power, the Ministry of Health, the Department of Health for Scotland and to a less extent, others. The Government organizations primarily responsible

for research are the Department of Scientific and Industrial Research, the Medical Research Council and the Agricultural Research Council. Each Department is concerned with particular aspects of the problem, which cannot be divorced from its other responsibilities. We are not suggesting any change in present departmental organization or responsibilities. The proposals made in this Report will, however, if adopted, be only the beginning of a heavy task which will occupy many years and will call for a combined effort by many different interests. There is the preparation and supervision of the programme of conversion to smokelessness with the synchronizing of fuel markets and fuel production, and the production and installation of suitable appliances. There is the watching and adjustment of the changing pattern of fuel user. There is continuous propaganda and education to be carried on. We are impressed by the large amount of vital research and development work to be done and we elaborate this in Appendix III. We therefore recommend that a 'Clean Air Council' should be appointed to co-ordinate all aspects of the work in future, to encourage research and development and to review the progress made in implementing any new legislation. It should submit an annual report to Parliament. The form of this body we must leave to be decided by Ministers; but that it is urgent and essential we have no doubt."

This is what the Act says:

" For the purposes of—

(*a*) Keeping under review the progress made (whether under this Act or otherwise) in abating the pollution of the air in England and Wales; and

(*b*) obtaining the advice of persons having special knowledge, experience, or responsibility in regard to prevention of pollution of the air,

the Minister of Housing and Local Government shall appoint a consultative council, to be called the Clean Air Council, of which he shall be the Chairman."

There is nothing in this that would prevent the proposed Clean Air Council being what we intended, namely an influential, authoritative and informed body with power to survey the whole field. It will not as now established by the Clean Air Act be an independent body, but that may not matter since the members if they are the right people may be relied on to be sufficiently independent in the expression of their views and the use of their influence. But should it so turn out that the Clean Air Council fail to be that lynch pin and inspiration we contemplated, and fail to set the pace in all this work for clean air, then the responsibility will fall back once more on the enthusiasts and the crusaders who have all along borne the brunt of the battle. This therefore is no time to reduce interest or effort; for we come back to the point where we started, namely that success will depend on public pressure.

I venture to say even before this Society that this matter of the most effective means of educating public opinion needs much more examination than it has received. We should not have to wait for a disaster, such as December, 1952, before Governments take action. Air pollution is " news." There is I think no paper that will not publish reports or items of information about air pollution. Anyone who employs advertising, measures the various mediums by the amount of attention that they can attract. A newspaper with a circulation, or a readership of millions, is, for common everyday products, worth much more than may be a much better produced paper which can only count its readers by thousands or tens of thousands. I would suggest that this is an aspect which the Society should take into careful consideration. In some ways it is obvious that both the immediate objectives of your Society and your methods will be changing, and I imagine that you may well be contemplating some reorientation of policy. If so, I think that you might find it

worth while to have as one of your principal activities the collection of pertinent and striking information, and the feeding of it into the popular press in a form that can easily and readily be accepted and understood. This education of the people must include the removal of their doubts and suspicions, the dealing with criticism in a convincing and sympathetic manner, an honest interest in the public you are addressing, and an absence of self-interest or special pleading, and above all the presentation of real facts. Well now, whether that is something that your Society can tackle or not is for you to decide. What I am sure of is that this work should be done; and clearly it will not be in any way within the field of the Clean Air Council as contemplated. It must be provided in some other way.

And so having thus briefly outlined the heavy work before us in attaining Clean Air and having apportioned tasks all round, I will myself retire from the active fray. But I hold myself in readiness for the next Committee!

INTERIM REPORT ON ACTIVITIES

At the Annual General Meeting that followed the Conference, the Chairman, Mr. F. J. Redstone, presented an informal interim report, which it was desired by the meeting should be included in this volume. The report was as follows:

Clean Air Bill—During the year the Executive Council, Technical Committee and Staff were largely concerned with the Clean Air Bill. Detailed consideration was given to each of its clauses, and steps were taken to secure the moving of a considerable number of amendments. Briefs were prepared for the use of members prepared to take them up, and appreciation should be expressed to Mr. Nabarro, Mr. Blenkinsop and others in the House of Commons, and to Lord Milner of Leeds, the Bishop of Sheffield and others in the House of Lords. The Society was one of the few bodies which continued their efforts into the final committee stages in the House of Lords. A number of the amendments that have strengthened the Act were due to, or were supported by, the Society.

The Divisions—Many meetings and visits have been organized by the Divisional Councils during the year. These have been both successful in themselves and most helpful in furthering the Society's aims and securing publicity for its case. Appreciation must be expressed to the Councils and in particular to their honorary officers, for their valued services.

Information and other Services—More and more time of the Staff at headquarters is taken up by services of various kinds—answering inquiries, supplying library publications and references, the loan of photographs and exhibition material and so on. There is also a steady flow of requests for speakers at meetings, for papers and lectures to be read, and for Press articles to be written.

One of the Society's tasks is the collection of information through press cuttings, periodicals and our own inquiries, so that we may be kept up-to-date in all that is happening in the air pollution field, both in this country and overseas. As the Society is widely regarded as a source of reliable information, this intelligence work is invaluable and does much to give the Society a useful prestige. In most cases it is done free of charge. Among other things it may be mentioned that we receive, read and classify over 7,000 press cuttings a year. The cost of this is becoming something of a problem, but it cannot easily be reduced.

Publications—Both the Year Book and *Smokeless Air* are achieving bigger circulations, and give ample proof that they are appreciated and that they help the Society " to gain friends and influence people." The new *Summary of the Clean Air Act* has proved to be very useful and is selling well. It should be regarded as an interim publication only—we hope in due course to prepare and publish a much more comprehensive booklet on the Act.

Publicity—Despite other activities, special attention has been given to the production of new exhibition units for use, in the first instance, in the West Midlands Clean Air Campaign, which is described in the current number of *Smokeless Air*. New small exhibits, for easy transport, have been added to those which are in constant demand on loan, and which go to all parts of the country. Two new small and inexpensive posters, and a new " give away " leaflet have also been prepared.

Internal Administration—The Executive Council and its Committees have been very active, not only on the

Clean Air Bill, but also in considering the proposed new constitution for the Society, which it is felt all members will agree is necessary. This has now come to include examination of the question of securing the Incorporation of the Society, a step which has many advantages and can strengthen the Society's position and add to its status.

The Society's basic difficulty remains, as in the past, the inadequacy of its income for the amount and variety of the work it is attempting.

Resolutions

The following Resolutions were put to the meeting, and were both adopted without dissent:

(1) That a Special General Meeting be held at an early date to consider proposals to revise the Constitution of the Society, and that these include a change of name to National Clean Air Society.

(2) That this Conference of the National Smoke Abatement Society welcomes the Clean Air Act and re-affirms its determination vigorously to pursue its policy of securing clean air. It urges:

(1) That since the effective implementation of the provisions of the Act largely depends on an informed public opinion, all local authorities should, without delay, initiate a well-directed plan of publicity and education.

(2) That local authorities should now take immediate action in order to be prepared to administer and implement the Clean Air Act.

(3) That the Minister of Health and the local authorities should take all necessary steps to augment the Public Health Inspectorate so that the provisions of the Act may be effectively implemented.

(4) That H.M. Government should take all necessary steps to make generally available supplies of smokeless fuels at prices which will favour their use.

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NATIONAL SMOKE ABATEMENT SOCIETY
Palace Chambers, Bridge Street, London, S.W.1

SOUTHPORT CONFERENCE

3rd–5th October, 1956

Members and Delegates Attending and Authorities, &c., Represented

List corrected to 25th September; for additions and alterations inquire at the Conference Bookstall

National Smoke Abatement Society

Southport Conference, 1956

LIST OF MEMBERS AND DELEGATES ATTENDING

Adams, E. (SI), *Swinton*
Adams, G. (PHI), *Whickham*
Adams, Cllr. G. R. F., *Felling*
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Akester, Miss J. M. (*See Programme*)
Alcock, Cllr. R. J., *Liverpool*
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Allen, Cllr. A. T., *Rhondda*
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Appleton, W. F. (CSI), *Portsmouth*
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Archer, A. (CSI), *Halesowen*
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Ashford, T. (SSI), *Glasgow*
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Atkinson, Cllr. J. J., *Crook & Willington*
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The Seventh Des Vœux Memorial Lecture

CLEAN AIR : THE NEXT CHAPTER

by

Sir Hugh Beaver

K.B.E., M.Inst.C.E., M.I.Chem.E., F.Inst.F., F.R.S.H.

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I FEEL specially honoured by being asked to give the seventh Des Vœux Lecture this year. Two years ago I spoke at your Annual Conference on the eve of the publication of the Report of the Committee on Air Pollution. I am not sure that it is appropriate for me to make any more speeches in this matter. I have made too many already, for it is as I have said two years since my Committee reported, and with its report the Committee and its Chairman went out of official existence. I would, however, like as it were to sum up—to sum up at least so far as I am concerned. So this is virtually my swan song.

I have chosen as title, *Clean Air—The Next Chapter*, because I hope, as we all hope, that we have with the passing of the Clean Air Act indeed opened a new Chapter; and that as we turn the page of 1956 we shall not find that we are still in the old dreary tale of the last 30 or 50 or 100 years. In a paper I read in America in the beginning of last year I detailed the wearisome cycles of complaint, committee, report—complaint, committee, report, repeating themselves ineffectively over and over again. The purpose of that paper was to show how public opinion is the decisive factor. That moral is just as pertinent now. If we look on the passing of the Clean Air Act as a milestone, it is well to remember that we only reached that milestone by the force of public opinion. And if in time to come we are to look back on the passing of this Act as the beginning of a new Chapter, it will be because public opinion will have both required and facilitated the effective application of the Act. The mere passing of the Clean Air Act could mean little more than have meant various legislative and administrative actions in this respect in the past.

It is in that light that I want today to make some sort of a national survey. Wars are generally supposed to be normally, though of course not always, won, or lost, in some one or other decisive battle; and there is generally no doubt about the decisiveness of a decisive battle. But there are no decisive battles in the war against air pollution—or at least it will be only in long retrospect that it will be possible to recognize that any particular action was in fact decisive. So let us not think today that you or we have won a great victory. It rests on the future and on what we make of the future, to decide whether it has been a victory; and whether the new Clean Air Act does in fact open a new chapter.

Now I want to make it quite clear that anything I may have to say about future action is not intended in any way to be mapping out a future for the N.S.A.S. I would not wish to seem to be either criticizing what your Society has done in the past, or advocating what it should do in future. Doubtless it has had and still has a part to play—how big, how important, must depend in large extent on your own selves. But doubtless too many others have a part to play. This is a matter in which there has to be a

surging tide of opinion and intention over the whole country, a tide that knows no ebb and which involves all interests and all individuals.

I am not going to start with any detailed comparison between the position—legal and administrative—before the passing of the Clean Air Act and after. I am not going to reiterate the new powers and the new action that the Act makes possible. Still less am I going to indulge in a jeremiad on what the Act does *not* contain. I am going to assume that you all have these matters at your fingers' ends. Whether or not it falls short in this or that respect of what you, or any of us, would have wished, it does provide scope for a great deal of action. My question today is how will it be operated, and what can we do between us to ensure that action is fully taken. We may properly remind ourselves that even the feeble legislation and powers of the past were not anything like exploited to their full. The same can happen again all too easily.

I want then to see:

What is the most that can be made out of this Act;

What has to be done to secure that the most is indeed got out of the Act;

What other action remains for us and/or Government to do to complete the campaign.

The Act starts with furnace smoke. Let us do so.

Furnace Smoke

So far as furnace smoke is concerned the whole responsibility now rests fairly and squarely—and most appropriately—on the shoulders of the local authorities. This was my Committee's recommendations which the Government accepted; and I have heard no criticism anywhere as to the decision. That in other directions some local authorities have claimed that they should have greater powers is not relevant to this issue of furnace smoke. And if furnace smoke is not to a very large degree hereafter controlled, the fault will or should be on the local authorities. But it will not be plain sailing; there are as I see it four serious difficulties.

In the first place there is the question of staff. My Committee referred to this in their report and I have myself elsewhere dealt with it at some length. All sanitary inspectors are agreed that it is better to carry people with you than to have to use, or threaten, sanctions; to persuade, rather than compel, the user of a furnace, whether industrial or commercial or private individual; if necessary to show him how the appliances or the fuel can be made to work satisfactorily. Only in the very last resort will compulsion and prosecution be used. But all this means staff. The field of observation and education and control is vastly increased and most local authorities are in no position to take on this new responsibility.

I had sent to me a few weeks ago an account of the debate over the latest annual budget for air pollution control in Los Angeles—which I may say amounted to $4,000,000—in the course of which the Chief Air Pollution Officer pointed out that " control of air pollution is not a problem that can be solved with finality; in the nature of things it is a continuous problem. If smog," he said, " is not to be with us permanently, permanent methods of preventing it will be." One must accept that; and where is the staff? In regard to smoke inspection I have before this stated that it is not in itself a profoundly scientific job; and I do suggest that inspectors of a lower level of qualification than a sanitary inspector could be used here as they are in the States completely effectively.

The second difficulty that I foresee is on this matter of the definition of dark smoke. I know that no one wants prosecutions, but in the end some prosecutions are inescapable; and if the courts develop an attitude of criticism or scepticism as to evidence tendered whether or not based on Ringelmann Chart 2 and comparisons with it, or of any other standard of measurements that may be evolved as

the result of the present efforts of the British Standards Institution, then a serious hole could be driven in this vital part of the Act. What would be ideal, and what I am quite sure is ultimately not unobtainable, is some form of factual registration of dark smoke. I have myself had some experiments carried out in an attempt to find some means of using photography scientifically instead of emotionally, as is the general attitude now. They have neither gone very far nor given much ground for hope. But this problem requires serious attention.

Again there is the as yet unsolved problem of infringement by night. But here I am sure that local authorities should be prepared to use Para. 4 of the Act, that is to say to persuade the Minister to use it, wherever there are good grounds for believing that infringement by night—though not by day—may be taking place. I think there should be some general agreement among local authorities as to what degree of measurement and recording would be adequate and reasonable. The British Standards Institution is I know preparing standard specifications for measuring instruments. These can be elaborate and costly, or simple and cheap. It may be that from the smoke prevention point of view the latter could be sufficient. My point is that a wide variation of attitude among local authorities, as to what is reasonable and adequate, will jeopardize ministerial action.

Finally there is the " unsuitable fuel " defence of Para. 1 (3) (c). My Committee did not believe in the alibi, and I hope that it will not be able to establish itself as a routine defence. I suggest that there should be a testing station, or more than one testing station, available where any coal so pleaded would be tried out in sufficiently comparable, or at any rate fair, conditions. That would put the claim to practical trial, and I think it would not often be required.

In all this there is as I see it scope for a certain amount of co-ordinated thinking and some research and experiment on the part of the local authorities. I suggest that they should have a small Committee or Working Party of their own to draw up a code of practice for themselves. The more they agree on their attitude and practice the more powerful will be their impact.

This same body could study and agree for itself—though the final word does not rest with them—the standards that they feel should be adopted in regard to the heights of chimneys. There is scope too, I feel, for such collective thinking in regard to the requirement of Para. 3 that new furnaces shall " so far as practicable be smokeless when burning fuel of a type for which the furnace was designed." Even the most experienced of Smoke Inspectors and Borough Engineers may find this not always an easy problem; and what about the great number of smaller local authorities? There seems to me to be every argument for combined thinking and study of this sort by the local authorities. This would reduce duplication of effort and assist the less well equipped local authorities; for to a large extent the smaller local authority has not the technical means to carry out these tasks. Moreover if the local authorities are to be really something more than merely the Minister's agents, they must be fully informed technically and scientifically. Any action such as I have suggested is completely legalized by Para. 25 (1) (a) of the Act.

Let us turn to the other side of industrial smoke: the special cases referred to in Para. 17. The intention of the Air Pollution Committee was that all industrial air pollution that because of technical difficulties in the prevention of dark smoke, grit, dust, etc. could not be dealt with under the general provisions of the Clean Air Act, should be subjected to a continuous and sharp challenge by a central inspectorate; to be composed of skilled and experienced chemists, metallurgists and fuel technologists. So long as no certain technical method is known to prevent any process being

a nuisance or a danger, then the "best practicable means" must be used; and in some cases, no means at all are as yet known. Now this means on the one hand adequate staff, and on the other effective direction of them. It is essential that both these factors operate. There are I think well over a thousand works which will come under the eye of the Alkali Inspectorate and many of them present pretty difficult, indeed so far intractable, problems. They can only be solved by research. Have the Alkali Inspectors the means of securing that adequate research and experiment is done? Certainly the means of research in industry, in research associations, in the D.S.I.R. exist; but will the Alkali Inspectorate have sufficient influence on these means? At any rate whatever the reason there are directions one could quote in which one may well doubt whether enough is being done.

The Act interprets "practicable" as you know, as "reasonably practicable having regard amongst other things to local conditions and circumstances, to the financial implications and to the current state of technical knowledge." Now what is going to be the practical application of this? As one reads through the Chief Alkali Inspectors' Reports one is struck by two types of remark. I will quote an example of each so as to make my point clear. From one report a few years ago I read:

"The national requirements of iron and steel are such as to necessitate the continued operation of the works (which are of course only referred to by a number) at high pressure although it is an uneconomic unit, which the owners would be glad to close. *It is understandable that the owners are averse to spending large sums on the works.*"

Or again in regard to two old power stations, "Complaints of smoke emissions from P.S. 70 and 72 were investigated. These are old stations which are used only at peak load periods and then as little as possible. The conclusion was reached that all reasonable steps were taken to avoid smoke emission."

The other type of remark is exemplified by the following, "Smoke and grit from coke ovens. There has been great activity in the building of new coke ovens and the replacement of old ones by modern batteries. Duplicate ascension pipes and gas collecting mains produce draught at each end of an oven and thus reduce the escape of smoke to atmosphere. The speed with which charging is effected is also an obvious factor and attempts have been made to accelerate the operation by improved designs of coal hoppers, the provision of vibrators and the fitting of charging lorries with rotating feed cables. Not all new coke ovens have been equipped with duplicate ascension pipes and gas collecting mains. Certain owners have refused to make this provision chiefly on the grounds of the additional cost of construction."

I quote these not by way of criticism of the Alkali Inspectorate, because indeed in many cases that they have dealt with in the past they have had no power to direct action. But now—at least if my Committee's views are followed—all these cases will be scheduled. If so then the suggestion I would like to make in regard to this sort of position is that in the case of old plant where it is considered uneconomic to take remedial measures on the grounds that the plant will soon go out of use, a definite time limit should be put to the acceptance of this argument. On the other hand in the case of new projects the plea of additional cost should be put into exactly the same perspective as is such a plea if advanced in regard to any other works where it may be necessary to protect the public, whether under bye-law or other statutory enactment, for instance the height of chimneys. It seems to me curious that when as is obvious great advances have been made in many directions, there should be no power, or the power if it exists should fail to be used—to require new plants to live up to the latest good

practice. I think one must look to the Alkali Inspectorate operating under the Clean Air Act to apply the same sort of treatment in such cases as is contemplated by Para. 3 in regard to new furnaces.

There is one more point that I would make in regard to these special cases, or scheduled processes, and that is I frequently notice in the Chief Alkali Inspector's Reports this sort of statement: " It is nevertheless not definitely established that the boilers are the main source of dust emission, there being other potential offenders in the locality." The Alkali Inspectorate owes much of its undoubted and beneficial influence to the fairness and friendliness of their approach; but I hope that the new Act means that we are departing in principle and for ever from the old attitude that unless the individual can be impeached for the whole of any nuisance, no action is justified. That is what bedevilled so much of the efforts in the United States, until public irritation forced the pace. Once more I must emphasize that I am in no way criticizing the Alkali Inspectorate; I am endeavouring only to survey what we between us all have to do in the future if we are going to turn the Clean Air Act into a real victory.

Domestic Smoke

Let us now turn to domestic smoke. I have elsewhere referred to, and others have detailed, all the various steps and the many interests involved in the creation of smoke control areas. At the risk of wearying you I will very briefly remind you.

There is the detailed survey of the proposed area, the calculations of the number and types of premises, houses, shops, offices, stores, etc., affected, the ascertainment of the different types of appliance to be converted and their number and the increased supplies of smokeless fuels required. The local authority obviously cannot make an order until it and the Minister are satisfied that the appliances will be forthcoming and the smokeless fuel or its equivalent available. Neither appliances nor fuels can be available unless their production has been planned and arranged and their use guaranteed well in advance. There is not only the question of production but that of distribution. Meanwhile there is all the statutory procedure of the making of the order, of local inquiry where necessary; securing of ministerial approval and the arrangement of finance; and then later the contracts for installing new appliances and so on. And in any large local authority's area various smoke control areas will inevitably be at various stages of establishment and development simultaneously. I will not enlarge; you can fill in the details for yourselves. But just consider all these and see what they involve and what Government Departments, Local Authorities, Industries, nationalized and private, and commercial interests are involved.

If it is the intention to secure the effective application of the Clean Air Act in 10 to 15 years, then, as has been pointed out over and over again, it is necessary to bring into operation smoke control areas in the so-called Black Areas at an average rate of something like 300,000 acres a year. As the start is bound to be slow and well below the average we must assume the normal sort of curve which would mean that from say the third to the ninth or tenth year from now new smoke control areas should be coming into existence at the rate of from 400,000 to half a million acres a year. This means the conversion of existing, or the provision of new, smokeless methods of space and water heating and of cooking in perhaps a million dwellings, shops, offices and buildings of every sort in a year, perhaps twice or more than twice that number of individual installations. If this is to be largely met by the use of smokeless fuel, coke and otherwise, as at the present stage of our knowledge it unquestionably must be, then it has to be produced of the right quality and at the right price at the rate of at least an additional million tons each year.

In the past the proposed creation of a smokeless zone has at any rate on one occasion been negatived on the grounds that the smokeless fuel and appliances were not available. But on the assurances of spokesmen of both the Ministries of Housing and Local Government and of Fuel and Power during the debates in Parliament on the Clean Air Bill that obstacle will no longer exist. There would be, we were told, sufficient smokeless fuel of one kind or another; or of gas or electricity. But in fact that will not come about by pronouncement only; it will not be the case unless a positive and co-ordinated programme of production and distribution is worked out. I am not sure where the responsibility for this lies, but I am sure that it is something that the protagonists of smokeless air must have under continual review. I have before suggested that the Institute of Fuel might well undertake to make an annual review of the known sources and position of all kinds of smokeless fuel, and the estimated requirements and resources for the following three years. You may think that such unofficial estimates would have too large a margin of error. They could obviously not be narrowly accurate; but they should be able to show with fair assurance the trends that are likely to develop from the known position in any year. Unless this information is assembled and made public, it seems to me impossible for local authorities or fuel merchants or appliance makers or the public to know where they are or how to make their plans. It may be that a blueprint of the clean air programme for the next five years is in active preparation somewhere, presumably in the Ministries concerned in England and Wales and Scotland. It may be that all the local authorities were being invited to submit their proposals for action over the next and following years, and that the resulting requirements are being calculated. It may be that a review has already been made of the availability of smokeless fuel in all the principal areas of the country next year and in 1958 and 1959 and 1960; and all the necessary steps being taken to fill any gaps. At any rate that is the action that one would expect to be being taken, if anyone or any authority intends to see that the Clean Air Act shall work. And it is not only necessary that such action should be taken, but that everybody should see that it is being taken and know the facts and figures.

Joint Consultation

Before I finally leave these subjects, I would point out that here too there is, as I believe, opportunity and need for joint consultation by the most experienced local authorities. They have to have both the will and the knowledge and the power to plan and carry out their programmes of smoke-control areas. Unless the local authorities know how to satisfy the local voters they will make little progress. They must know what good coke or other smokeless fuel means, what it should cost, what servicing is required and what types of appliance are going to give satisfaction. Unless they know all this and secure that their people get them, the whole scheme will break down in a storm of complaint and protest.

I want to turn now for a while to some of the things that the Act is not going to do; where it leaves things largely as they were, mainly because for one reason or another the means and the necessary knowledge to deal with these things do not exist. As has been pointed out over and over again, neither the Air Pollution Committee's Report nor the Clean Air Act attempted to cope with the problem of toxic gases, and in particular with the all prevailing sulphur dioxide. I have heard it claimed that Paragraph 17(3) of the Act gives the Minister power to schedule SO_2 in a general way among the noxious and offensive gases. I cannot believe that that would be seriously argued, but even if action were so taken it would in present circumstances and on our present knowledge be a dead letter. We may as well be honest and admit that. But I think our Report made

our position and our view abundantly clear. We considered that these toxic gases were a problem to which all the resources of research and experiment must be turned—medical, chemical, mechanical, administrative. We were struck and I still am struck by the gaps in our knowledge—as to the effects of toxic gases, as to the reasons for these effects, and as to the means of preventing or alleviating those effects. We were struck too—and I am not aware that the position is any better now—by the lack of co-ordination between the efforts of different enthusiasts and investigators. We pointed out for instance that the clinical work by a few hospital doctors and general practitioners was apparently hardly linked at all with such medical research work as was going on—and that any chemical research work was unlinked with either. I believe that an inter-departmental committee has since been collecting and assessing all the research problems connected with air pollution—both the work in hand and the work that needs to be done. That seems an excellent step, and if it has reached such a stage as would permit the publication of the results, then I think that this should be done. But it does seem to me that this is not a matter that can be adequately dealt with on a departmental basis alone, and I hope that that is not intended. This matter of research, and I mean programmed objective co-ordinated research, on the question of toxic gases is of vital importance. I believe that the Royal Society of Health could do a great service by arranging a conference designed to survey the whole field and to open up all the sources, and so stimulate action.

Road Vehicles

There is a related matter in which the Act brings no improvement and that is in regard to the control of road vehicle exhausts. This is becoming the primary objective of attack in many cities in the United States and particularly of course in Los Angeles. Very large sums have already been spent both by motor manufacturers and others on the problem of the prevention of toxic motor exhausts. Is adequate research being done in this country? I suggest that the approach to this problem should be similar to that followed in regard to the scheduled processes, namely of continual informed challenge, and the insistence on the incorporation of best known methods—as soon as these are established—at least in all new motor vehicles. My Committee recognized that this evil cannot be cured by police control; it still remains in the category of aspects of air pollution that still have to be tackled. This road vehicle problem is bound to become of increasing seriousness, and I am bound to say that I do not think that present regulations and present responsibilities are going to cure the evil.

I am not going to attempt to show in any further detail what sort of problems and what sort of action lie before us if we are to see the Clean Air Act effective and if we are to consolidate this first advance and set out to storm the next position. If I have not so far succeeded in convincing you—even supposing any action on my part to be really necessary with such an audience—then no further elaboration by me would be effective. What at all times impressed my Committee and what I believe must impress you and everyone who studies this question is the complexity of interests involved, It was for that reason that my Committee set great store by the creation of a Clean Air Council; and a Clean Air Council has been established by the Act. I think it is worth while re-stating what my Committee had to say:

" For purposes of central administration, air pollution is a matter with which several Government Departments are concerned—the Ministry of Housing and Local Government, the Ministry of Fuel and Power, the Ministry of Health, the Department of Health for Scotland and to a less extent, others. The Government organizations primarily responsible

for research are the Department of Scientific and Industrial Research, the Medical Research Council and the Agricultural Research Council. Each Department is concerned with particular aspects of the problem, which cannot be divorced from its other responsibilities. We are not suggesting any change in present departmental organization or responsibilities. The proposals made in this Report will, however, if adopted, be only the beginning of a heavy task which will occupy many years and will call for a combined effort by many different interests. There is the preparation and supervision of the programme of conversion to smokelessness with the synchronizing of fuel markets and fuel production, and the production and installation of suitable appliances. There is the watching and adjustment of the changing pattern of fuel user. There is continuous propaganda and education to be carried on. We are impressed by the large amount of vital research and development work to be done and we elaborate this in Appendix III. We therefore recommend that a ' Clean Air Council ' should be appointed to co-ordinate all aspects of the work in future, to encourage research and development and to review the progress made in implementing any new legislation. It should submit an annual report to Parliament. The form of this body we must leave to be decided by Ministers; but that it is urgent and essential we have no doubt."

This is what the Act says:

" For the purposes of—

(*a*) Keeping under review the progress made (whether under this Act or otherwise) in abating the pollution of the air in England and Wales; and

(*b*) obtaining the advice of persons having special knowledge, experience, or responsibility in regard to prevention of pollution of the air,

the Minister of Housing and Local Government shall appoint a consultative council, to be called the Clean Air Council, of which he shall be the Chairman."

There is nothing in this that would prevent the proposed Clean Air Council being what we intended, namely an influential, authoritative and informed body with power to survey the whole field. It will not as now established by the Clean Air Act be an independent body, but that may not matter since the members if they are the right people may be relied on to be sufficiently independent in the expression of their views and the use of their influence. But should it so turn out that the Clean Air Council fail to be that lynch pin and inspiration we contemplated, and fail to set the pace in all this work for clean air, then the responsibility will fall back once more on the enthusiasts and the crusaders who have all along borne the brunt of the battle. This therefore is no time to reduce interest or effort; for we come back to the point where we started, namely that success will depend on public pressure.

I venture to say even before this Society that this matter of the most effective means of educating public opinion needs much more examination than it has received. We should not have to wait for a disaster, such as December, 1952, before Governments take action. Air pollution is " news." There is I think no paper that will not publish reports or items of information about air pollution. Anyone who employs advertising, measures the various mediums by the amount of attention that they can attract. A newspaper with a circulation, or a readership of millions, is, for common everyday products, worth much more than may be a much better produced paper which can only count its readers by thousands or tens of thousands. I would suggest that this is an aspect which the Society should take into careful consideration. In some ways it is obvious that both the immediate objectives of your Society and your methods will be changing, and I imagine that you may well be contemplating some reorientation of policy. If so, I think that you might find it

worth while to have as one of your principal activities the collection of pertinent and striking information, and the feeding of it into the popular press in a form that can easily and readily be accepted and understood. This education of the people must include the removal of their doubts and suspicions, the dealing with criticism in a convincing and sympathetic manner, an honest interest in the public you are addressing, and an absence of self-interest or special pleading, and above all the presentation of real facts. Well now, whether that is something that your Society can tackle or not is for you to decide. What I am sure of is that this work should be done; and clearly it will not be in any way within the field of the Clean Air Council as contemplated. It must be provided in some other way.

And so having thus briefly outlined the heavy work before us in attaining Clean Air and having apportioned tasks all round, I will myself retire from the active fray. But I hold myself in readiness for the next Committee!

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LORD HYNDLEY'S ADDRESS AT THE OPENING

OF THE NATIONAL SMOKE ABATEMENT SOCIETY'S

EXHIBITION IN MANCHESTER

"FUEL EFFICIENCY IN INDUSTRY AND HOME"

22nd November, 1950

My Lord Mayor, Ladies and Gentlemen,

I am very glad to be here to-day at this first post-war Exhibition of the National Smoke Abatement Society on "Fuel Efficiency in Industry and Home". I am pleased to see it has received such wide support.

The National Coal Board, who are the producers of the "offending object" (namely the raw coal which is the principal cause of the smoke nuisance) - are in full agreement with the aims and objects of the Society. That may sound a bit Irish; so let me explain. As well as producing raw coal, the Board also produce a large amount of smokeless fuels. For instance, we have coke ovens in most of our Divisions; last year they produced $6\frac{1}{2}$ million tons of coke. Most of it was used in the production of iron and steel, but nearly 2 million tons went to other industry and into domestic fires and boilers. We also make Phurnacite. This is a specially carbonised briquette that can be used instead of anthracite. It is made in South Wales, and we are extending the plant so as to produce double the present quantity. Then there is anthracite. The Board produce about $3\frac{3}{4}$ m. tons of anthracite each year; but it is in such great demand for export that I'm afraid there is not much left over for use at home. All the more reason, therefore, why we must be sure that this limited amount of sized anthracite is used as efficiently as possible. So the Board, in consultation with the coal distributors and the manufacturers and distributors of modern solid fuel appliances, have made arrangements so that the smaller sizes of anthracite go only to those consumers who have selective appliances specially designed to burn them. This scheme is known as "The Small Anthracite Supply Scheme". It is working well and has enabled us to satisfy consumers whose appliances cannot work satisfactorily on any other fuels.

So much for the solid fuels themselves. But the Board's interest does not end there. We are also anxious to see that they are used efficiently. That is why the Board are closely associated with the Coal Utilisation Joint Council, which also includes the Coal Distributors and the Manufacturers and Distributors of Solid Fuel Appliances. The Council's objects are to promote the efficient use of solid fuels in modern domestic appliances. They stage a series of Exhibitions around the country each year - at the Building Trades Exhibition, the Ideal Home Exhibition, Agricultural Shows and, of course, you will find their Stand at this Exhibition to-day. They are now in process of developing a Service and Showroom Scheme through which it is hoped to provide a complete sales and servicing organisation which will compare with that offered by the other fuel industries. The aim will be not only to give sound advice on the choice and correct installation of modern appliances, but also to provide efficient after-sales service and maintenance and to give guidance on the most suitable types of solid fuel to use. A Centre has been opened in London where the staffs of the Appliance Distributors and Coal Merchants can be fully trained in

this/...

this work and where advice can be given to visiting Architects, Builders and other people who are interested. The Council have given, and are always ready to give, advice, not only to private householders, but also to official bodies.

All this will, I am sure, help us to become more efficient users of solid fuel. There is immense scope for improvement. I am sure I am not far wrong when I say that every single home in the country can do with at least one new and more efficient appliance - a fireplace, a stove, a boiler or the like. By making them really efficient, the householder will not only be doing a great service to the nation but also - and this should be most welcome to everyone these days - he will cut down his household expenditure surprisingly.

When the Service and Showroom organisation I mentioned just now is fully developed it will obviously help your Society greatly; for there is no doubt that a properly installed and operated modern solid fuel appliance gives off very much less smoke than the older types of ranges and open fires.

But we want to see more than that done about the smoke problem. Take the suggestion that there should be smokeless zones. Several such proposals have come from Lancashire - and indeed from Manchester itself - which is hardly surprising! To-day only very little of our household solid fuel is smokeless, and there is not much prospect, in the immediate future, of having anything like enough smokeless fuel to go round very much further. But that does not mean we should sit down quietly and say that smoke emission is inevitable and must be accepted. If the hopes of the Simon Committee about increasing the production of smokeless fuels are not likely to be realised, is it not possible to develop appliances capable of burning bituminous coal smokelessly? Intensive research is being carried out on this problem both by individual manufacturers and organisations such as the British Coal Utilisation Research Association. It can, I think, be claimed with some confidence that the problem of designing a closed stove which will burn bituminous coal smokelessly is within sight of solution. But smokeless burning in an ordinary open grate is a much more difficult problem and, frankly, will take a long time to solve.

Now I have heard it said that there are other ways of cooking and heating than by solid fuel. I have even heard that some people prefer something called electricity or something else called gas - though I can't think why! Perhaps Dame Vera will sometime be good enough to explain - at least about gas.

9 Now a word about the industrial user. He, as well as the householder, must use his fuel efficiently - and with as little smoke as possible. Now industry's demand for coal is increasing by leaps and bounds.

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In the first ten months of the year the consumption of coal by industry and Public Utilities has increased by 3.8 million tons over that for the same period last year. Unfortunately, the production of coal is not rising proportionately. We shall have the greatest difficulty in meeting the demand at home and abroad. It is therefore, an urgent National need that industry at home should improve its methods of using coal. Greater efficiency ought to mean less smoke and that, in turn, will help your Society towards its aim.

In short, it may be true to say that: "Where there's smoke there's fire"; but we must see to it that it need not be true that "Where there's fire there's smoke".

In this I can assure you of the complete goodwill and whole-heated support of the National Coal Board. The problems are complicated and difficult. But Exhibitions of this kind enable the public to see the great strides which have been made since the War in the design of appliances and can do nothing but good.

I wish your Society every success in their great work and I have much pleasure in declaring this splendid Exhibition open.

With the Compliments of:-

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